THE

ELECTRICAL REVIEW.

VOL. XLV. OCTOBER 27, 1899. No. 1,144.

CONTENTS:

	PAGE
The Municipal Management of Electricity Works	661
The Magnetisation of Cobalt (*illustrated*)	664
Brush Rocker Details and Bearings (*illustrated*)	665
The "Same Circuit" Method of Incandescent Lamp Photometry (*illustrated*)	667
Reviews:—Arithmetic of Electrical Measurements	668
Lezioni di Elettrotechnica dettate nel R. Museo Industriale Italiano in Torino	668
Manual de Télégraphie et de Telephonie	669
Arc Lamps and How to Maintain Them	669
Oil Engine Tests	669
Prof. Smith on Governors	669
The London County Council	670
Correspondence:—Single-Phase Motors	670
Aluminium Conductors	670
Measurement of the Internal Resistance of Accumulators	671
What is a Factory?	671
A 600-KW. Inductor Alternator for Sheffield (*illustrated*) ...	672
Business Notices, &c.	673
Electro-Pneumatic Signalling (*illustrated*)	679
Brisbane Electric Tramways (*illustrated*)	682
City Notes	688
Traffic Receipts	690
Stocks and Shares	690
Share List of Electrical Companies	691
Market Quotations	692
Railway Power Distribution over Large Areas	693
Volta and the Voltaic Cell	694
Electric Traction in South Staffordshire (*illustrated*)	696
Some Features of the Electric Induction Motor (*illustrated*) ...	697
The Penalty Clause	698
Fog Signalling on Railways	699
New Patents	699
Abstracts of Published Specifications	700

THE

UNIVERSAL ELECTRICAL DIRECTORY

1899

Edition

Price 6s.

NOW READY.

H. ALABASTER, GATEHOUSE & CO.,

4, LUDGATE HILL, LONDON. E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON.

Telegraphic Address: "AGNEKAY, LONDON." Code A B C.
Telephone No. 968 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free per Year, 19s. 6d. To all *other countries*, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 2s. or Free by Post (in Great Britain), 2s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU 22, Rue de la Banque. *Berlin:* ASHER & Co., 13, Unter den Linden.

Cheques and Postal Orders (on Chief Office London, to be made payable to Mr H. ALABASTER, 4, Ludgate Hill, E.C.

THE MUNICIPAL MANAGEMENT OF ELECTRICITY WORKS.

THE mental attitude of many present-day students of social problems is crystallised in the phrase that the municipality can do no wrong. It would be idle to deny the remarkable success that has attended the entry of municipalities into electric lighting; the lowest cost of production and the lowest charges to consumers; these are to be found among municipal undertakings. With the glamour of these results strong upon us, it is held almost treasonable to utter anything against the policy of municipal ownership. But despite the list of successes that have followed municipal effort, the honest doubter may have occasional misgivings as to the real soundness of communal enterprise. We admit that it is a great achievement to be able to show what are, on the face, better results than are usually presented by a private undertaking; but it is important that we should not be entirely led away by them. In the conduct of an electricity works it would be unwise to measure success by the cost of coal per unit, or even the total cost per unit; there are other figures to consider besides the mere production. It is obvious that the relation of capital charges to cost of production provides the real test of the commercial soundness of an undertaking, and we are afraid this is occasionally lost sight of when comparative statements are made concerning the achievements of a company and those of a municipality.

There is no doubt a wide difference between the objects of a municipal electricity works and one owned by a private company. In the latter case the interests are well defined, and they do not pretend to go beyond those of the shareholders. But the rights of the customers and the interests of the shareholders are not so incompatible as municipal advocates would have us believe. On the contrary, we are persuaded that a generous treatment of electricity consumers brings an increased reward to the proprietors. Among municipalities great doubt exists as to what should be done with the surplus; while some strenuously argue in favour of reducing rates, others persistently refuse to aid the general body of ratepayers. Though the credit of the ratepayers may be risked to only an infinitesimal extent in the initiation of electricity works, it ought not to be lost sight of that each and every one has a distinct interest in it, and until a municipality brings the supply within the reach of all its constituents, it ought not to be unmindful of those ratepayers who are at present outside the pale of electricity supply.

We are not anxious to start a time-worn controversy, but it is certainly a somewhat curious fact that, until the advent of electricity supply, municipalisation had not taken very firm root. It is true there were corporation gas and waterworks, but the success in the working of these had not been very striking. The supply of electricity is a much more

technical and complex undertaking than either gas or water, and that being the case, it is, perhaps, noteworthy that municipalities should have achieved success in it. Probably the very fact of its involving scientific knowledge may partially account for its success, for naturally a body of men who could not grasp the principles underlying the generation and distribution of electricity would be compelled to rely on their engineer, and in consequence he would be permitted to follow his own bent in the development of the supply system. Almost without exception, the most conspicuous examples of success in municipal electrical undertakings have been achieved in those instances where the engineer has been given a free hand. It is unnecessary to quote actual cases, for they must be sufficiently obvious to most engineers. Not for a moment do we suggest that the ignorance of committeemen has been always a stepping stone to the success of an electricity works; on the contrary, we are familiar with some local authorities who, in their inability to appreciate the economics of their electrical undertaking, have actually refused to follow the advice of their engineer to purchase an economiser. Under such circumstances the ignorance of the lay mind must be held responsible for extremely uneconomical methods of working. Again, on the other side, one remembers instances where a municipality, being unable to discriminate between sound and unsound engineering, has permitted its engineer to run riot with his fads. Now, whatever may be the shortcomings of a supply company, and occasionally they are many, we cannot conceive of any directorate of business men embarrassing their engineer in the execution of his multifarious duties. Presuming he carried out his work well, to which he would enjoy their confidence, and would be free from the personal attacks he would be occasionally subjected as an officer of a corporation. Moreover, a board of directors would be able to detect, probably more quickly than an electric lighting committee, whether an engineer was developing the system on sound lines, and we think so because a director stands in a different position to a committeeman. No matter how much interest committeemen may display in their electrical scheme, they are not interested in its success in precisely the same sense as a director is. In these days of company promotion and company failure a director is a more or less discredited person, but though we hold no brief for the company's case, we feel no hesitation in saying that the ornamental director is almost unknown in electrical companies. In the development of the electrical supply business, there has seldom been the necessity to hang out delicate baits to hook the public, and hence the electrical director is generally a hard working, sound man of business.

Whatever may be said against the primary principle of municipal ownership, it has become a very real and vital part of our social life, and it is quite reasonable to presume that there will be a wide extension of the system, both in electrical lighting and tramways. Having regard to this widespread acceptance of the principle, we would, in all earnestness, counsel the members of municipalities to modify some of their views regarding the position and duties of an electrical engineer. We have indicated already that an electrical committee may be, under some circumstances, exceedingly well served; yet in one of the most successful municipal schemes in the country the chief engineer, who has had experience in both municipal and private undertakings, has declared, in the strongest possible manner, that it is infinitely preferable to serve a company than a municipal authority. The position of some municipal electrical engineers is almost grotesque, and perhaps the greatest surprise is that electrical men will occasionally suffer indignities in silence. In some instances the very authority of the engineer in his own works is usurped by members of committee, who, ever willing to discover trouble, readily incline their ear to the complaints of the staff. Such a proceeding is invariably attended with disastrous results, and the engineer must either resign his position or be ever afterwards discredited in the eyes of his subordinates. There are some municipalities which have adopted the most unwise course of making their electrical engineer subordinate to the local surveyor. We have nothing to urge against the ability of municipal surveyors in their own sphere, but it is impossible that they should possess without special training the knowledge to control electricity works. Such a dual arrangement can never be successful; the electrical engineer may be blamed for failures and the surveyor may be credited with the successes. Experience is entirely against such a practice, for almost without exception trouble in some form or another has arisen from making the surveyor the nominal head of the electricity works. There is very little doubt that the labour element in municipal life is strongly antagonistic to electrical interests; it is the labour members of a Vestry or a Town Council who insist upon the insertion of objectionable and foolish clauses in electrical contracts, and, curiously enough, it is the labour member who is most troublesome to the resident electrical engineer. If there should be a complaint from a stoker, it is magnified by the labour member into a dispute, and if the electrical engineer requires an increase of salary, the objections arise mainly from the labour section. Most municipalities at the moment are engaged upon schemes of considerable magnitude, which will involve the expenditure of large sums of money, and though we do not for a moment imagine that any electrical engineer would be anything but unswerving in loyalty to the Corporation which he serves, yet we think his tasks would be materially lightened if members of local authorities were to extend to him a little more generous treatment. There are some municipalities whose attitude towards their engineers and officers is one of courtesy and consideration, and in no instance can that fail to produce excellent results.

Aluminium for Electrical Purposes.

During the past few weeks we have given some brief particulars of American electrical transmission schemes, in connection with which aluminium is employed for the purpose of electrical conductors. The Snoqualmie Falls system, in Washington State, employs some 67,000 lbs. of this metal of ·26 inch diameter, and 72,000 lbs. of ·23 inch diameter, for transmitting the current from the power station to transformer stations, and from thence to the point of utilisation. The lines extend for a distance of about 20—30 miles. Another similar undertaking is found in California, where aluminium conductors are employed for transmission between the Blue Lakes power house and the Stockton sub-station. The line is 40 miles long, and consists of aluminium weighing 4,194 lbs. per mile. Details are occasionally coming to hand from other parts of America and the Continent, of the utilisation of aluminium in this way, but so far as

this country is concerned, the developments have not been so great as might, perhaps, have been expected. The only case we know of is that of the Northallerton Electric Light and Power Company, which has made use of aluminium conductors, for which the wire was supplied from the Foyers works. The latest reports received are to the effect that it is giving satisfaction. But, apart from this, our progress has been rather slow, although sure. As our readers are already aware, the Foyers Company has for some time past employed aluminium wire for both lighting and power purposes, and also for telephones, while certain electrical supplies firms in London and elsewhere are experiencing a demand for such wires for electrical use. The Foyers works have turned out trolley wire for an electric tramway system, but we believe this particular installation has not yet been completed. Among the other interesting developments may be mentioned negotiations with the General Post Office, having in view the adoption of aluminium wires for long distance telephony. As a matter of fact, a length of line has been put up for this purpose for trial. The question of jointing is of great importance, and several forms of joints have been tried, but we are not in a position at the moment to say which form has so far proved the most suitable, although they are all more or less so. It is believed that inquiries for aluminium for electrical work will increase when engineers get to know more about the properties of the metal. Of course, it is not for a moment to be expected that aluminium will be able to replace copper for insulated conductors, because the larger section would involve a very much greater expenditure upon insulation, but for bare conductors of telephone lines, &c., it possesses several distinct advantages over copper. We hear various reports from time to time that the prevailing high prices of copper will not continue long, but it is difficult to indulge in prophecy with much likelihood of accuracy. Whatever may be the developments of the next few months in the price of copper, the cost of aluminium at present is considered to give it a considerable advantage under this heading, although we are given to understand that the British Aluminium Company has always been prepared to deliver aluminium in whatever form it is required, at a cheaper rate than copper can be obtained at. Secondly, the saving in weight ought to be taken into consideration. For the same conductivity, aluminium will only weigh half the weight of copper; this means, for instance, that in the case of telephone lines, a considerable saving can be effected in the number of poles, and in the ease of transport, especially where the conductors have to be carried to places difficult of access, there ought to be a considerable saving in freight.

Municipal Authorities and Electric Supply Competition.

The Association of Municipal Corporations has again, by formal resolution, pledged itself to do everything that lies in its power to defeat all large electric power schemes under which the promoters may desire to compete with existing municipal electricity works on their own ground. Their efforts are brought to bear in this direction with a view to preventing injurious effect upon installations established in the interests of ratepayers. We believe the members of this Corporation underestimate the benefits that many of the larger ratepayers (factory and works owners, &c.) in the interested localities, would derive from a cheap, plentiful, and efficient supply of electrical energy. We are inclined to think that in many places where municipal electricity works have been established, the question of large power supplies did not receive anything like the merited attention (even if it does now!) until the schemes now assailed were introduced. The installations were started primarily for public and private lighting purposes, and there is plenty of scope for municipalities in that direction. But we maintain that the supply of large quantities of power for such purposes as are now under consideration was not entertained or even considered within the range of possibility, but it is now such a crying necessity that Parliament would be fully justified in allowing a private company to come in to provide what the local authority does not, and cannot, give so cheaply. We believe that the injury to municipal works is more fanciful than real. Doubtless the Association mentioned, has renewed its deliberations and vows, in prospect of the promised reintroduction in the present Parliamentary session of the Bills which were ruled out last year. For ourselves we hope that in the interests of the electrical industry and of power users generally, the measures will meet with more success this time. That they are timely proposals to meet a great want is indisputable; the only point against them seems to be the question of injury to municipal plants. This is one way in which our municipal system, as it exists at present, militates against the prosperity of our national industries. To them, what is more essential than cheap motive power?

Concentration *v.* Subdivision of Electricity Works.

Commenting recently upon the "follow-my-leader" tendency which it observes in the design of electricity works, an esteemed contemporary takes the breakdown which left Manchester in darkness for 10 hours, as a text upon which to base an argument against the general practice of providing single stations for the supply of large areas. In support of this contention, it is alleged that continuity of supply must be the paramount consideration in the design of the system of supply, outweighing even cheapness of production. To a certain extent we are in agreement with this view; there can be no doubt that interruptions of supply have in the past caused great injury to electrical undertakings, especially where these were in direct competition with similar systems, but we join issue with our contemporary when it is said that several generating stations should be scattered about a large town instead of concentrating the plant in one building. The first thing to be considered, in the interests of the proprietors—whether these be shareholders or ratepayers—is how to supply electrical energy most cheaply to the consumers. In our opinion this is best achieved by bringing the whole of the generating plant together under the eye of the chief engineer, and simplifying the system of supply to the last degree possible. To avoid accidents, such as the one cited above, the sub-division of the generating plant into groups, each complete in itself from boiler to dynamo, would constitute a valuable precaution; the sub-division might even be carried as far as the switchboards and feeders, leaving the distributing network to form the only connecting link between the groups, in which case there would be practically as much safety as with separate stations, without the divided responsibility and increased staff required by the latter. "Fashion" is not always to be condemned; it is at present the fashion to equip tramways with electrical plant—long may this endure! Moreover, if every engineer were to follow the bent of his own ideas, what an extraordinary perplexity of designs would be brought forward! At a time when "standardisation" is universally called for, an outcry against fashion seems to us to be singularly inappropriate and thoughtless. The very fact that a certain design becomes generally adopted is in itself presumptive evidence that the design is a good one; we see this process taking place all round us, in every department of life, and while it does not follow that in every case the design adopted is the only good one of its kind, yet it is tolerably certain that it has real and substantial advantages as compared with its predecessors.

D

THE MAGNETISATION OF COBALT.

A very complete account of the magnetic properties of cobalt is given in a paper read before the Physical Society in June last by Prof. Fleming, A. W. Ashton, B.Sc., and H. J. Tomlinson.* Cobalt stands next to iron in its susceptibility to magnetism, and although determinations have been made of its magnetic constants, no very complete set of observations on the magnetic hysteresis values of commercial cobalt have hitherto been made. This investigation therefore fills a gap in our knowledge, and we give a short account of the most important results obtained.

The experiments were made on a circular ring of the metal, cast by Messrs. H. Wiggin & Co., of Birmingham, the outside diameter of which, when turned up, was 13·84 centimetres. A chemical analysis showed that the metal contained nearly 1 per cent. of iron, 1 per cent. of nickel, and 1·36 per cent. of carbon, besides small quantities of other substances.

The ring was wound with primary and secondary coils of insulated wire, and the induction was measured by the ballistic galvanometer in the usual manner.

The first set of experiments consisted in taking careful sets of complete magnetic (B.H.) cycles; and from these the hysteresis losses in ergs per cubic centimetre per cycle, corresponding to known maximum flux densities, were calculated by measuring the delineated areas. A Steinmetz curve (fig. 1) was then constructed showing the relation of the hysteresis loss in each cycle to the maximum induction for that cycle.

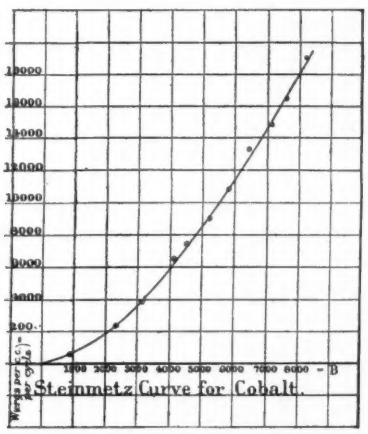


FIG. 1.

This was converted by taking logarithms (ordinary) of both variables, and plotting a logarithm curve (see fig. 2). This last curve proved to be nearly a straight line.

If W = magnetic hysteresis energy loss in ergs per cubic centimetre per cycle, and
B = maximum flux density (induction) during the cycle,
I = maximum magnetisation during the cycle,

then the logarithmic curves show that over a wide range

$$W = 0{\cdot}01\ B^{1{\cdot}6},$$
$$W = 0{\cdot}527\ I^{1{\cdot}62}.$$

These exponential expressions show that the relation found by Steinmetz for iron and steel, and by Kennelly for nickel, holds good also for this sample of cobalt, namely, that the hysteresis loss varies as the 1·6th power of the maximum flux density during the cycle.

It is remarkable that for materials differing so much as the cast cobalt and soft annealed transformer iron, the hysteretic exponent should in both cases be so near 1·6. At low inductions, however, the hysteretic exponent increases in value in all cases. In the case of iron it is well known that magnetic hysteresis becomes zero before the maximum induction becomes zero. There is, in fact, a non-hysteretic range of cyclical magnetisation. Hence it follows that for some small value of the maximum flux density, there must be a range of flux density during which hysteresis increases from zero to a finite value; in other words, its rate of change is then very large. Hence $\log_{\cdot 10} W$ will have a very large negative value corresponding to a certain small value of

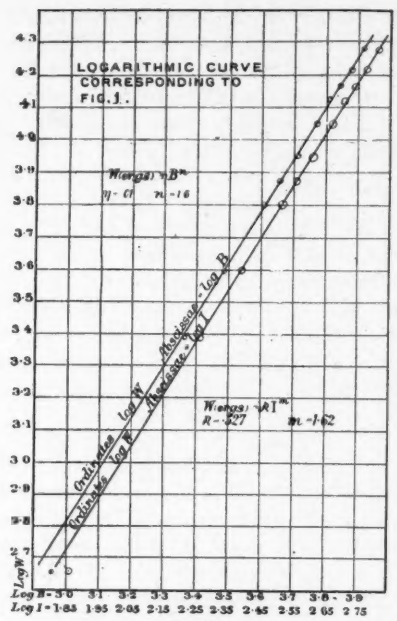


FIG. 2.

$\log_{\cdot 10} B$, and accordingly it follows that the hysteretic constant, n, which is represented by the tangent of the inclination of the line (log. W . log. B), cannot have the value 1·6 throughout all values of B max., but must increase as B max. decreases. That this is also the case for the sample of cobalt is well shown by the lowest observation points on the logarithmic curve (fig. 2).

It is usual to express W in terms of B, but the authors consider that it would be better to express W in terms of I, since of the three magnetic vectors, H B and I, I has reference to the properties of the material itself, B to those of the material and the space it occupies as well, and H may be

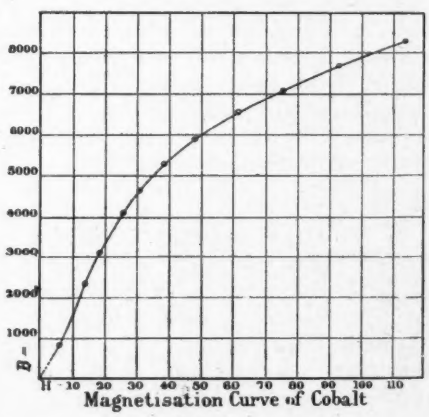


FIG 3.

looked upon as denoting the space qualities only. Hence magnetic material qualities, like W, should be expressed in terms of I rather than B; the logarithmic curve connecting $\log_{\cdot 10} W$ and $\log_{\cdot 10} I$ is given in fig. 2.

The observations furnished a simple magnetisation curve for the metal (fig. 3), and a series of values of the permeability stated in terms of flux density, B, and of the magnetic force, H.

Corresponding experiments were made on a ring of cast-iron of a quality used in dynamos. The results are interest-

* *Phil. Mag.*, Sep., p. 271.

ing for comparison. The following tables show the values of the induction and permeability for various magnetising forces in case of the specimens of cobalt and cast-iron which were tested.

Magnetisation Curve, Permeability, and Hysteresis Values of Cast Cobalt.

H	B	μ	Hysteresis loss in ergs per cc. per cycle.	Hysteresis loss in watts per lb. per 100 cycles per sec.
6·67	911	137	452	·254
13 23	2,341	177	2,454	1·379
17 91	3,106	173	3,956	2·222
25 76	4,110	160	6,292	3 535
30 53	4,589	150	7,374	4·143
38 56	5,216	135	8,953	5 029
48 54	5,869	121	10,937	6 144
61 08	6,519	107	13,235	7 436
75·46	7 052	93	14,642	8·226
93 18	7,622	82	16,518	9·280
114 03	8,237	72	18,950	10 646

H is the maximum value of the magnetising force during each cycle.
B is the maximum value of the flux-density or induction.
μ is the value of the permeability corresponding to the annexed values of B, and the hysteretic losses also corresponding to the values of H and B are given in ergs and watt-seconds.

Observations on the Magnetic Hysteresis of Cast-Iron. Magnetisation Curve.

H	B	μ	H	B	μ	H	B	μ
·19	27	139	8 84	4,030	456	44·65	8,071	181
·41	62	150	10·60	4,491	424	56·57	8,548	151
1·11	206	176	12·33	4,884	396	71 98	9,097	126
2 53	768	303	13 95	5,276	378	88 99	9,600	108
3 41	1,251	367	15·61	5,504	353	106 35	10,066	95
4·45	1,898	427	18·21	5,829	320	120·60	10,375	86
5 67	2,589	456	26·37	6,814	258	140·37	10,725	76
7·16	3,350	468	36 54	7,580	207	152·73	10,985	72

BRUSH ROCKER DETAILS AND BEARINGS.

By E. K. Scott.

Brush-holder spindles which are simply fixed in a round bush as shown in fig. 1 have a very awkward habit of turning round when not expected, and so releasing the pressure on the brushes. Various ways of keying the spindle by means of fibre or hardwood pegs are shown in figs. 2, 3 and 4; in the figs. 2 and 3 they pass through the cast-iron rocker, the insulating bush (shown in section), and the spindle. None of these, however, can be said to be a really good job, and the best way undoubtedly is to hold the rocker spindle in a square bush as in fig. 5.

This last figure shows some features the writer introduced on a line of machines which he designed for the Brush Company. It will be noticed that the nut holding the brush spindle

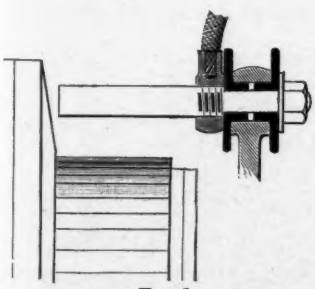


Fig. 1.

in position is on the commutator side of the rocker, instead of being outside as shown in fig. 1. The advantage of this is that the brush-holders may be easily removed by simply slackening off the nut and drawing out the spindle. With the usual arrangement it is generally necessary to dismantle the complete brush rocker to get at the holders, as the spindle

Fig. 2.

Fig. 3.

Fig. 4.

comes close up to the upright of the commutator segments and cannot be drawn back.

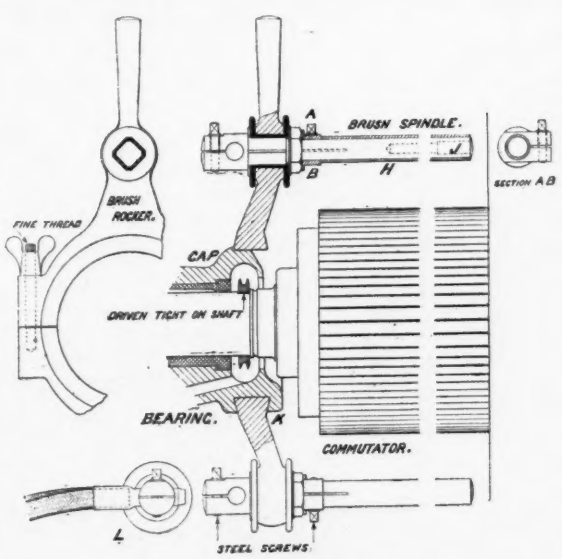


Fig. 5.

Another advantage of this construction is that it enables the connection with the flexible cables to be made direct on to the brush spindle as shown in fig. 5. The joint shown here, and in figs. 6 and 7, is so immensely superior to the ordinary cable eye or taper socket that it has always puzzled the writer why it has not been more generally adopted.

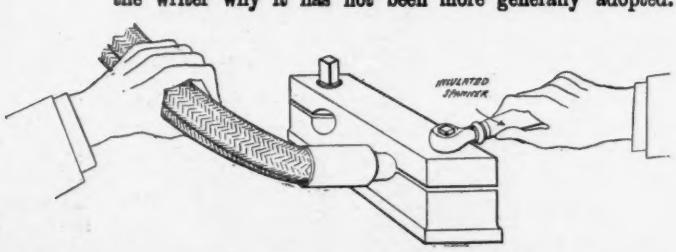


Fig. 6.

The idea came over to this country with the introduction of the Siemens and Halske brush-holder, and the writer employed it on some dynamos as early as 1892. The ad-

vantage of the arrangement for high tension work will be obvious from fig. 6. As some readers probably know, terminals which are supposed to be dead have a knack of being connected up after all.

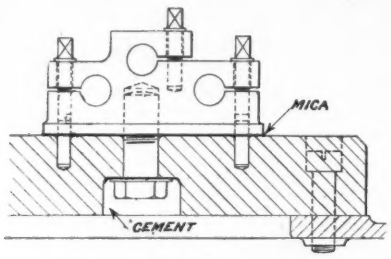


FIG. 7.

Some specifications have asked that all the brushes should be capable of being lifted off the commutator at once, and where there are six or more side by side it is a convenience. One way of carrying this out is to mount a sleeve H (see fig. 5) on the brush spindle. This sleeve carries the holders, and being split at the rocker end, the screw shown in section A, B, can be used to clamp it in any position. In multipolar machines all the brushes on the various spindles may be lifted together by rotating the rocker spindles slightly, the necessary movement being given to them by attaching arms which project inwards to a central ring capable of rotation. The spindles are prevented from moving except when required by anchoring this ring firmly.

A quick and slow adjustment for the brush rocker is sometimes asked for, so that when a large increase of load comes on, or in shutting down, the brushes can be pushed over quickly. Messrs. Holmes have a rather neat method of effecting this, which is shown in fig. 8. The rocker revolves on a fixed ring, A,

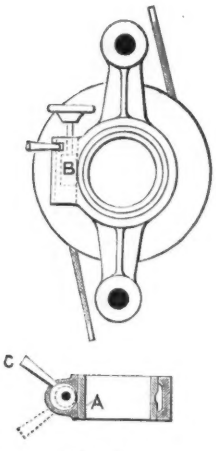


FIG. 8.

having worm-wheel teeth cut into its periphery, and into which the worm, B, gears when the handle, C, is in the position shown in the full lines. If, however, it is turned over to the dotted position, the worm is lifted out of gear on account of its spindle being mounted eccentrically, and the rocker may then be pushed sharply backwards or forwards by hand.

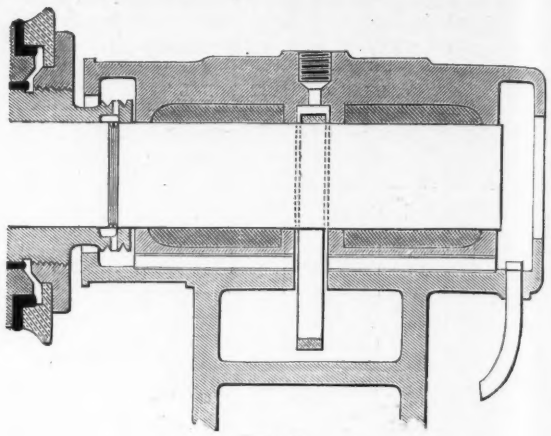


FIG. 10.

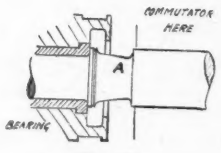


FIG. 11.

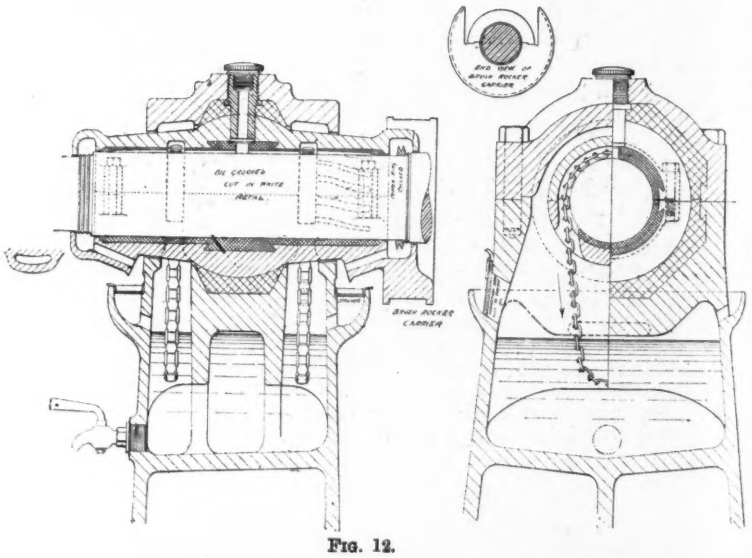


FIG. 12.

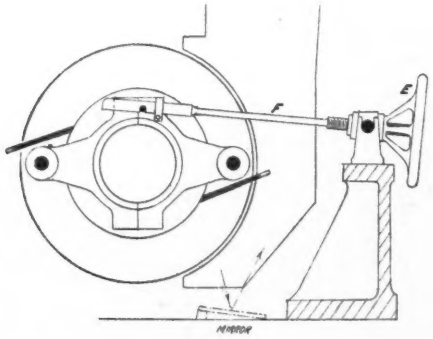


FIG. 9.

Another method somewhat similar to an arrangemen which the writer put on a double commutator machine for a Lancashire central station, is shown in fig. 9. As the fine adjustment had to be effected some distance away from the brushes, the hand-wheel, E, acts as a nut to the connecting link, F. If occasion should arise when the brush rocker requires a quick movement, one has to lift up the link slightly and adjust the rocker by hand. By turning the hand-wheel, the notch in the link can then be allowed to fall into position again.

The condition of the brushes can be observed in an awkward place, such as a commutator next to the fly-wheel of a Belliss or Willans engine, by fixing a small mirror in the position shown dotted.

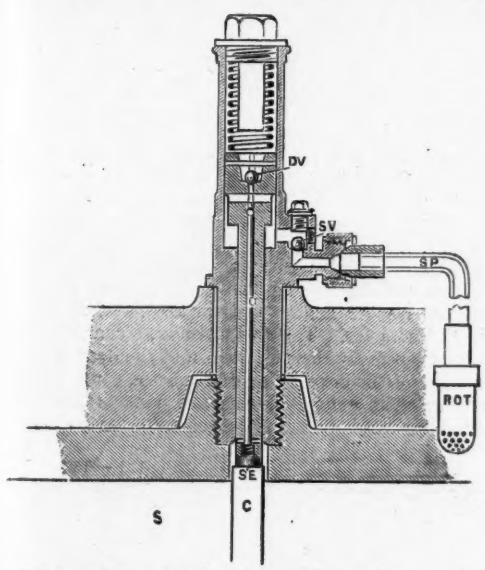
In assembling a brush rocker and fittings together, it is advisable to thickly shellac varnish the insulating bushes, so

that when they are tightened up the crevices are filled, and there will thus be no opportunity of moisture getting in.

Oil creeping along the shaft and getting on to the brush rocker has often given trouble. The creeping is best prevented by having efficient oil-throwing grooves cut into the shaft, but sometimes the grooves are arranged on a separate ring, which is caulked tight on to the spindle, or else they are cut on a projection of the commutator bush, as shown in fig. 10. If turned in the shaft they should have a very sharp edge to throw the oil efficiently, but care must be taken to have the bottom of the groove well rounded out, otherwise the spindle may be very much weakened. As the centrifugal action tends to cause the oil to run up on to the largest diameter when it escapes from the end of the bush, creeping towards the commutator may be prevented to some extent by turning down the shaft, as shown at A in fig. 11.

In ordinary two-pole and small multipolar machines the rocker is commonly carried on a projection of the end bearing, and as the joint of the bearing cannot be made very tight it sometimes happens that there is a leakage of oil. By adopting the method shown in fig. 12 the rocker need not come near the joint at all, and should it be necessary to remove the top bush, this can be readily effected without interfering with the brush gear. The arrangement is similar to that employed by Messrs. Johnson & Phillips. Of course, in multipolar machines the commutator becomes so large in diameter that it is better to carry all the brush gear by brackets attached to the magnet yoke. In fact, for those machines in which the armature is mounted on the engine shaft this is the only possible construction.

The design of swivel bearing shown in fig. 11 is one which the writer got out some years ago, and there are two features in it which may be worth mentioning. The first is that the seat for the bush is made of white metal which is run in, when the armature has been placed central in the polar



D V, Delivery valve; S V, Suction valve; S P, Suction pipe; R O T, Rose in oil tank; S E, Steel end; C, Cam; S, Shaft.

FIG. 13.

space. In this way machining is dispensed with, and the pedestal may be cast in one piece with the bedplate, giving a cheap and neat-looking construction. The second feature is the use of chains for lifting the oil instead of the usual loose lubricating ring or the original fixed Mohler ring.

This chain method, first introduced on the Brush-Falcon dynamos, proved so successful that it was adopted on the Mordey alternators and other machinery. One advantage of the method is, that as the links dip down much lower into the well the height of the oil need not be gauged to such a nicety. The chain also lifts more oil than a plain ring, and can therefore be used on shafts running at slower speeds. It is specially made of stamped iron links so arranged that the chain may be easily divided at any point by simply turning one of the links at right angles to its usual position.

With the ordinary ring it is necessary to remove the bearing to get it off. Messrs. Thomas Parker, Limited, have, however, got over this difficulty by making the ring in halves, hinging one side and having a snap joint at the other. When the speed of a shaft falls much below about 220 revolutions, both oiling ring and chain methods fail, and the bearings must then be supplied by a small wheel pump working on the same principle as the Roots blower and driven from the dynamo spindle, or else as in the Electric Construction Company's machines by a small plunger pump (see fig. 13), worked by a cam or eccentric cut on the shaft. Messrs. Thomas Parker, Limited, have adopted a similar device, but the pump in this case is on the lower side of the bearing, and oil therefore flows into it by gravity.

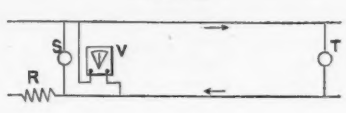
THE "SAME CIRCUIT" METHOD OF INCANDESCENT LAMP PHOTOMETRY.*

In the measurement of the candle-power of incandescent lamps, it is customary to use as a working standard of comparison at one end of the photometer some form of standard oil burner, or a previously tested incandescent lamp carefully maintained at its rated voltage. A simple kink of photometric work known as the "same circuit" method, which does away with the bothersome oil burner and eliminates any calculation involving voltage, has come into extended use by lamp manufacturers, but does not as yet seem to be generally appreciated and used as it might be by central station men. It is based on the principle that if two incandescent lamps are supplied from the same circuit, and are burned at about the same brilliancy, their candle-power will increase and decrease in the same proportion with changes of voltage, and their relative candle-power will remain constant.

If, then, a working standard is mounted on one end of the photometer bar and the lamp to be tested at the other end, and both are supplied with current from the same source, even if the voltage fluctuates, the candle-power of both lamps will go up and down together, and the relative candle-power or the position of the photometer screen over the scale will remain constant. Obviously no accurate voltmeter measurement is needed in this method of working.

The connections when working in this way are shown in fig. 1, where S is the standard lamp and T that under test, connected across the same leads supplied from a source of power at the left. If this source of power is of a much higher voltage than that of the lamps—as it is likely to be in central stations having a considerable drop in their

FIG. 1.



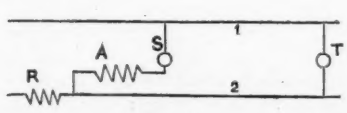


FIG. 2.

feeders—a rheostat should be inserted at R to cut down the pressure and to avoid deterioration of the standard, as well as to bring the two lamps to about their normal voltage. Care should be taken in this case not to turn off the lamp, T, as the reduced drop in R would raise the pressure on the standard, S. Wherever a pressure within 2 or 3 volts of that for which the lamps are rated is available, no resistance is necessary.

A voltmeter may be inserted, as shown, in order to have the lamps at about their rated voltage, since, if the voltage is raised considerably above, or lowered considerably below, normal, the candle-power of the lamp under test might not go up or down exactly the same percentage as that of the standard lamp unless both filaments were of the same physical characteristic, and particularly possessed the same ratio of graphitic to base carbon. Over considerable fluctuations of

* *American Electrician.*

voltage, however, such as 3 or 5 per cent., the candle-power of all lamps varies in so nearly the same proportion that the adjustment of the voltage, with any care whatever, is not necessary. The adjustment of the lamps to normal candle-power by the eye is quite sufficient, so far as accuracy of the measurement is concerned. The meter may, however, be useful to prevent overburning the standard. Obviously the reading of this voltmeter does not enter into the calculation of the candle-power which is read off immediately from the scale.

When it is desired to test lamps all of one rated voltage, the system is obviously most simple, and when lamps of different voltages must be tested, the only addition necessary is a number of working standards, one for each different voltage. If it is not desired to keep in hand and calibrated so many different working standards, one may be made to serve over a small range of voltage by means of an adjustable photometric scale. For instance, if the working standard gives 16 C.P. at 112 volts, 110-volt lamps may be compared with it by sliding the scale to favour the lamp under test by the difference between the candle-power of a lamp burned at 110 and 112 volts. In the same way the 112-volt standard may be used for testing 114-volt lamps by sliding the scale in the other direction, *i.e.*, to favour the standard, to a point determined by a graduated set of marks on the instruments. The tests may be carried out as explained above, with a pressure on the lamps equal to or somewhat less than that at which the working standard is rated, and either steady or fluctuating.

To reduce the number of standards required for a photometer designed to measure a general line of lamps from 50 to 250 volts, another modification may be made by inserting a resistance in series with the standard lamp alone. The arrangement of the circuit in this case is shown in fig. 2, where the added resistance is represented by the letter A. This resistance should be made adjustable, and may be calibrated so that even in this case no voltmeter measurement is necessary. An explanation of the proper value of this resistance is best given by taking a specific case. Assuming that the lamp, S, gives 16 C.P. at 100 volts, and T is rated at 110 volts, the resistance, A, should be sufficient to absorb just 10 volts and give S 100 when the voltage between wires 1 and 2 is 110. The two lamps will then both receive their normal voltage when the difference of potential between the wires, 1 and 2, is 110 volts, and will rise and fall in candle-power equally when the pressure varies. If the resistance of A is increased sufficiently to give a drop of 12 volts out of 112, it adapts the instrument to measure lamps of the latter pressure. Thus the photometer may be made to measure lamps rated at any pressure above that of the standard, in this case assumed to be 100. The resistance of A may be made adjustable with a contact travelling over a scale direct reading in terms of the voltage to which the resistance adapts the standard lamp, so that when it is desired to measure lamps rated at 114 volts, for instance, the contact is set opposite the 114-volt mark, &c. The resistance should, of course, have a negligible temperature coefficient.

Portable photometers of extreme simplicity and light weight may thus be made and fitted with three standards, one for lamps of 55 volts or thereabouts, another for 110 volts or thereabouts, and a third for 220 volts or thereabouts. The "same circuit" method should prove of the greatest value in central station photometry where the simplicity of its apparatus and circuits, the absence of several simultaneous readings, the total elimination of corrections and calculations, and the ability to work over a considerable range of pressure, steady or fluctuating, should commend it for use in place of any other method.

REVIEWS.

Arithmetic of Electrical Measurements. By W. R. P. Hobbs. Seventh Edition. London: Thomas Murby.

This book is intended to set forth clearly and concisely the application of Ohm's law to electrical measurements *in practice*, and consists of short explanatory notes and worked examples, followed by numerous test problems. In spite of its practical aims, the work has a strong flavour of "science and art school" teaching, as exemplified by the repeated use of such expressions as "multiple arc," joining cells "for quantity," "electromotive force at the terminals" of a battery or dynamo, &c.; while four chapters are given up to academic problems founded on the coupling of cells in parallel and series, and in opposition to one another. The author identifies the "best effect" with the "strongest current," ignoring the inefficiency of this arrangement.

We should not be sorry to see a text-book issued which ignored the existence of primary cells altogether. There is a misprint of + for × on page 52; Minotto is, as usual, wrongly spelt Menotti; a "constant variation" is mentioned on page 94; and "conductivity resistance," whatever that may be, on page 110.

Lezioni di Elettrotechnica dettate nel R. Museo Industriale Italiano in Torino. By Galileo Ferraris. (Published under the auspices of his family and of the Italian Institution of Electrotechnics.) Vol. I. Turin: Roux, Frassati e Co.

Galileo Ferraris was born in 1847 in Livorno-Marcellese, and died in February, 1897. His short life of 50 years was one of incessant literary and scientific activity. His first publication, a paper on "Teledynamic Transmission," was printed in 1869, the year of his graduation at Turin. Of his early work the best known is a book on "Geometrical Optics and Optical Instruments," which has been translated into several languages, and is still used as a text-book in Germany. His future reputation will undoubtedly rest mainly on his discovery of the rotating magnetic field, the principle of action of the modern two and three-phase transmissions of power; he was experimenting on this in 1885, but no account was published till 1888, when he read a paper before the Academy of Sciences at Turin describing his results. "In 1886," we quote from a contemporary journal, "Prof. Ferraris was appointed by the Minister of Public Instruction to deliver a course of lectures on 'Electricity' to graduate engineers at the Industrial Museum of Turin. These lectures, to which the Professor has devoted a great deal of activity, were a marked success from the beginning. The attendance increased from year to year, and at present the lectures furnish the leading course of electrotechnics in Italy. These lectures are models of their kind, and of the highest scientific character. Their conciseness, a charming literary form, and especially their expression of the deep feeling and enthusiasm of the devoted man of science, cause them to be interesting to an unusual degree, and make those who had attended the course proud of the honour of having been pupils of Prof. Ferraris."

These lectures were never published by Ferraris himself, but some of his pupils have collaborated in publishing them, after his death, from their own notes, as an expression of respect and devotion for their late teacher. The passage we have quoted above, and the editorial preface to the volume, are both eloquent of the man's inspiring personality and scientific distinction, while the volume itself cannot fail to impress the reader as being a highly philosophical statement of the existing views of electrical science.

Prof. Ferraris (we quote from the preface) had himself intended to publish a treatise on practical electricity, or else a series of monographs on the subjects taught in the schools. He had actually realised part of his design by writing "A Geometrical Theory of Vectorial Fields," which was intended to form the first chapter of the introduction to his treatise. This essay was presented to the Academy of Sciences in Turin some months after the death of Galileo Ferraris, with a brief preface by Prof. Corrado Segre, and was published in the "Memoirs of the Academy," Vol. xlvii., 1897. From the character of this fragment it is clear that the complete work, matured in his singularly lucid mind, would have been of capital importance both to science and to engineering.

The present volume contains only the theoretical part of the course, and is complete in itself. The treatment is

essentially geometrical, and the attention is constantly fixed on the vectorial distribution in space. Symbols are employed mainly for statement; there is little mathematical process.

This volume may be followed later by a second on the applications of the theory.

Manual de Télégraphie et de Téléphonie. By J. Pierart. New Edition. Bruxelles: En Vente Chez l'Auteur.

This is a handy and up-to-date little book and really contains an immense amount of information judiciously condensed.

The first four chapters are headed "Electricity," "Batteries," "Magnetism," and "Electro-Magnetism." In "Electricity" the writer does not deal with the usual "sealing wax and pith ball" description, but plunges at once into the subject of how electricity can be produced, and gives brief descriptions of certain of the phenomena and laws of electricity, descriptions quite sufficient for the purpose. "Batteries" are dealt with at a greater length. Descriptions of the various kinds of batteries are given briefly; also the faults to which the cells would be liable in practice are referred to, and the way to pick out a bad cell is stated. It may be questioned if there was really any necessity to have described the Bunsen cell, seeing that it is never employed for either telegraphic or telephonic purposes, and the space occupied in the description might, perhaps, have been more usefully employed. The accumulator being now extensively used in telegraphy, comes in for a suitable amount of attention. "Electro-magnetism" is well dealt with, the descriptions of various kinds of electro-magnets, as used in telegraphy, being satisfactory. Chapters V., VI., and VII., dealing respectively with "Telegraphy," "Telephony," and "Simultaneous Telegraphy and Telephony," form the bulk of the book, and are very practical in their contents. Necessarily they deal with the subjects from a Belgian point of view, though not exclusively so. It is perhaps a little curious that the English standard relay should be simply designated "Standard Relay;" it may be remarked that the resistance of each bobbin is incorrectly stated to be 600 ohms; 200 is the standard value to which these relays are always wound, giving 400 in "series," and 100 in "multiple;" possibly, however, these relays are used in Belgium, wound to 600. The latter country being the home of the Van Rysselberghe system, simultaneous telegraphy and telephony naturally come in for a fair amount of notice.

Altogether, the book is a good one, and is very unpretentious.

Arc Lamps and How to Maintain Them. By H. Smithson and E. R. Sharpe. 1899. London: Whittaker & Co.

This little book is addressed to the ordinary consumer, and is intended to show him how to treat an arc lamp, to keep it in good order, and to effect minor repairs. The mechanism of a number of well-known lamps is described, but the total absence of illustrations of the working parts greatly detracts from the value of the descriptions; the style is disconnected and rambling, and the matter does not bear evidence of the 10 years' experience claimed by the authors.

On page 13, dealing with two lamps in series, only one of which lights up, they say that the fault may be due to "no circuit!" The kilowatt is repeatedly called a unit, meaning a Board of Trade unit; a "large leakage" is called a "short circuit"; a method is hinted at by which incandescent lamps are used to indicate leakage from one wire to another, or a short circuit. The normal length of an open arc is given as $\frac{3}{32}$ inch; this is much too short. The enclosed arc is said to burn in a partial vacuum, which is absurd. For 10 and 12 amperes, positive carbons of 18 mm. are recommended, with negatives 11 mm.; 15 and 11 mm. would be more correct. One valuable piece of advice is given—when lamps cannot be got to burn well, *call in an electrician who understands arc lamps!*

OIL ENGINE TESTS.

The oil engine is gradually achieving for itself a position as a recognised motive power, and the July trials carried out by the Highland and Agricultural Society of Scotland serve as a reminder of this, and the figures obtained will become the new standard of comparison for oil engines for some time to come. We observe an improvement upon previously recognised figures of comparison.

The trials carried out at Edinburgh were made necessarily on such small engines as could be taken to an agricultural show, the largest being of 20 B.H.P., and the only oils used were Russolene and Royal Daylight, costing 6½d. per gallon at Edinburgh, but any ordinary oil appears suitable within reasonable flashing points. The power was tested by a rope brake.

The full load trial on the first day was 4 hours, the full load being the declared B.H.P. On the second day a 2 hours' run was made at half load, and finally every engine was run up to its maximum performance. Engines had to start cold, and time was noted in the getting up to full load. The Trials Committee report that the engines all ran well except in two cases where there were outside reasons for some little difficulties. They were all fairly economical. The largest engine tested was one of 20 B.H.P. by the Campbell Gas Engine Company, of Halifax, with 12½ × 21 cylinder. It ran at 190 revolutions, weighed 5 tons, and is listed complete at £280. It required 31 minutes to start it from cold, in each case the longer time being generally required by the larger engines, Crossley's 16 B.H.P. requiring 18¼ minutes, though Tangye's engine of 17½ B.H.P. only required 15 minutes, and, moreover, it developed 18·06 B.H.P., the engines of Crossley and Campbell falling below their declared power, though Campbell's smaller engine of 13 B.H.P. did 13·87 B.H.P., and most of the other engines did more than was promised. After all, however, the ratio of I.H.P. to B.H.P. is perhaps more important than the ratio of performance. Crossley and Campbell were almost equal at ·771 and ·773 mechanical efficiency, while Blackstone and Tangye ran fairly close at ·858 and ·842, other engines had no indicator facilities. The oil consumption differed considerably, Crossley getting off with ·793 lb. per B.H.P. against Campbell's 1·2 lb. and Blackstone's engine only using ·746 lb. per B.H.P. From the figures as a whole we may lay down a useful rule for practice, that the mechanical efficiency and the oil per B.H.P. are at best of the same value ·75 or three-quarters. This is a convenient figure for memory, and those makers who do not approximate to this figure should seek the fault. Russolene gave both the best and the worst results in different engines. Royal Daylight gave the second best and the second worst results, so that the two oils may be rated equal. One engine only did better at half than at full load—Campbell's smaller 13 B.H.P. engine—which at 6·73 B.H.P., reduced its oil per B.H.P. from 1·2 to 1·180, all other engines showing an increase.

On maximum effect Campbell's large engine added over 27½ per cent. to its rated B.H.P., whereas Crossley's added only 12½ per cent., and Blackstone's large engine over 40 per cent, while their other engines added over 30 per cent. to their declared power.

The prices for engines appears to be about £14 per B.H.P., or £11 per minimum H.P., though Tangye's, and Pollock, Whyte & Waddel gave 1 B.H.P. for £8 and £7.

About ·75d. may be taken as the hourly cost of an oil engine in fuel for first-class work, when at full power, with oil at 7·5d. per gallon. In other words, a first class oil engine will produce 1 B.H.P.-hour for $\frac{1}{10}$th of the cost of a gallon of the oil it consumes.

We think there should be some more uniform and standard method of rating oil engines. The declared B.H.P. of one engine was 14 for a speed of 200, whereas the same size and stroke were rated by another maker at 13 for 210 revolutions, and yet another, even larger, was rated only at 10 B.H.P. for 220 revolutions.

The prices for engines bear a fairly even ratio to their claimed B.H.P., but the trials show that some makers are much more liberal in their sizes than others.

PROF. SMITH ON GOVERNORS.

Prof. Smith, who writes on governors in *Feilden's Magazine*, has done good work and has been looked on as being in touch with practice, but if *Feilden's Magazine* is intended to be practical it must print different matter from the article in question. As an example of fine professorial diction it is first class, but it is so wrapped up in verbiage and abstrusely technical phraseology as to be almost unreadable. Technical details are wanted plain. Now, how is this for comprehension: Prof. Smith wishes to use the pitching of a ship to regulate the steam at the engine, and this is how he tries to convey the idea of doing so:—"The mechanical resistance of the water to the rotation of a marine propeller in rough weather varies violently in accordance with the relative positions of the stern post and of the water surface in passing through the wave crests and troughs, and this change of geometrical relation may be made to operate (telegraphically, and by help of an electric or mechanical relay) a central gear, &c." While writing this it might have been as well to have made a little clearer the medium in which the propeller revolves; apparently it revolves in rough weather rather than in water.

The foregoing sentence represents the general tone of the whole lengthy article in which there is doubtless some valuable matter, but it is so concealed and swathed in the bandages of a mummified terminology as to be deprived of any useful significance. Prof. Smith decries the almost general effort of designers to seek a variation of speed for

the purpose of effecting a governing operation, thereby utilising the error it is sought to avoid to actuate the controlling mechanism. There are other phenomena than speed that might be so utilised, such as stress, induction, current, &c. The series winding of the fields of a compound wound dynamo is instanced as a type of governor which acts at once by the increased magnetism induced by the increase of current which would otherwise cause a loss in E.M.F. This governing action takes place without alteration of speed. The engine governor, which acts by the change of the speed it is meant to control, acts as though in a dynamo it were endeavoured to keep up the pressure by a control apparatus operated by the fall of pressure.

Among other devices, reference is made to the bellows governor—a corrugated sheet metal vessel—whereby the variation of pressure in a boiler is made to vary the current. A different form, known, we believe, as Smith's, was, and probably still is, much used in the North, and in competent hands is an admirable contrivance for maintaining a steady steam pressure. We have seen the same effect secured by means of a cylinder and piston device.

It is suggested to govern electrical engines by a series electric current control operating upon the engine valves. With modern sensitive and powerful governors of the shaft type, governing appears hardly to require much finer apparatus, at least for high speed engines.

It is also suggested that change of driving effort and resistance might be utilised as a means of control. Stripped of its efflorescence we take it that something which will alter under varying stress might be placed between, say, a fly-wheel and a dynamo that would very quickly vary the mass volume of the elastic fluid flowing from the steam generator through the channels of communication terminating at the container of the distribution mechanism attached, or in propinquity to the cylindrical vessel containing the piece which moves under the elastic force of the actuating fluid of the heat engine, to such distribution mechanism container. We hope this is clear. We have endeavoured to imitate the style of the worthy professor. Clearly! he would vary the cut-off by a spring resistance in the driving shaft—a sort of coupling.

Incidentally Prof. Smith is inclined to attribute many fly-wheel accidents to want of arm strength rather than to rim failure, and it is probable if the arms of a fly-wheel did shear off, that the rim would drop and break so quickly that the true cause of failure might be unperceived. Taking account merely of the rim strength, the absorptive power in foot-pounds per pound of weight is $\frac{E}{W}$ = nearly $\cdot 3 \frac{n}{N} \times$ centrifugal stress in pounds per square inch of rim section. Then, if $\frac{n}{N}$ = 1 per cent., and sectional stress is limited to 4,000 lbs. per square inch, the limit of absorptive power for cast-iron is 12 foot-pounds per pound of rim per 1 per cent. of variation. But this may be increased by making the arms radial tie rods with initial tension of considerable amount, and a cast-iron spider with hollow arms is suggested to contain the tie rods. The Professor would turn the arm ends to a circle less than he would bore out the facing seats inside the rim, and he would pull the rim to a seat on the arm ends by tightly screwing up the tension rods. This, he thinks, would enable higher speeds to be run with safety. We need not follow the remainder of the article into the question of ball governors, and when Prof. Smith writes again, we hope he will not endeavour to "write fine." Surely Prof. Smith has written long enough to have written plain English. Certain technical terms are absolutely necessary, but there are times when it is distinctly better to call spades spades, and not digging implements or—any other sounding phrase.

LONDON COUNTY COUNCIL.

At a meeting of the Council on Tuesday the chairman of the Highways Committee stated in reply to questions that the Committee intended at an early date to present a report to the Council in regard to the statements of Mr. Hanbury in relation to the telephone service.

The Council's Power Station.

The Council adjourned for a week the consideration of a report by the Highways Committee, stating that Prof. Kennedy had expressed the opinion that the Council's southern tramways and the proposed additional tramways and light railways could be worked by means of one generating station constructed on the site of the Council's tramway depôt at Camberwell. Part of the depôt is the Council's freehold, while the remainder is held on a lease, of which about 75 years are unexpired, at a rent of £250 per annum. Mr. Kennedy also suggested that, as eventually this generating station would be an extremely important one, it was desirable that compulsory powers should be obtained for the acquisition of the freehold of the portion of the depôt now held on lease, and also of certain houses abutting upon the north-east corner of the depôt, and the property on the east between the depôt and Camberwell New Road. The buildings on the additional property, if acquired, need not be immediately pulled down, but the property would probably be obtained on better terms in the near future than if the purchase were to be deferred until it became obvious that its acquisition was essential for the growth of the generating station. The cost of the acquisition of the freehold and of the interests in the property adjacent referred to above, would be about £90,100; and the Committee was of opinion that the suggestion should be adopted, and the property scheduled as to be acquired under the powers to be sought by the London County Council Tramways (Electric Traction) Bill. The committee recommended accordingly, but the consideration of the question was postponed.

The Proposed Palace Line.

It may be remembered that in July last the Council decided to obtain powers for the construction, among others, of an electric tramway on the underground system between Rushey Green and the Crystal Palace. The Highways Committee then thought that the property, consisting principally of forecourts of houses, and parts of estates not yet built upon, required to widen some portion of the route sufficiently to enable a double line to be laid, could be acquired at considerably less cost by negotiation with the owners than if the Council should obtain compulsory powers for the purpose. The Council's valuer had been in negotiation with the owners for the acquisition of the necessary property, but had not made such progress as would justify the Council in proceeding with the proposal. Having regard to all the circumstances, the Council decided, on the recommendation of the Highways Committee, to abandon this particular electric tramway scheme.

Lighting of Nelson's Column.

The Highways Committee reported that the Charing Cross and Strand Electricity Supply Company recently applied for permission to carry an electric cable overhead from the Union Club, Cockspur Street, to the Nelson Column, Trafalgar Square, for the purpose of lighting the column on Trafalgar Day. As the circumstances were of a special character, and the matter was urgent, the committee had, on behalf of the Council, given consent to the erection, so far as the Council had power, upon the following conditions:—That the work be carried out in accordance with the provisions laid down in the regulations (A 16 to 26) of the Board of Trade with regard to overhead electric lighting wires; that the main used be for supply at a pressure of not more than 200 volts; and that the whole of the work be removed, and any damage that may be done to the public streets in connection therewith be made good, within 10 days from October 20th. The span of the cable, which was carried from the Union Club to the column by means of steel suspending wires, was slightly in excess of that allowed by the Board of Trade regulations, but the Board raised no objection to this deviation from the general rule.

CORRESPONDENCE.

Single-Phase Motors.

In your issue of the 13th inst. I notice a letter from Mr. C. E. L. Brown, referring to an article by Mr. Eborall on the above subject. As this letter might give rise to an error with regard to the meaning of my single-phase motor, Patent No. 29,499, of 1896, I now take this opportunity of replying to it.

According to Mr. Brown's letter, he appears to think that what I have patented is, that with single-phase motors having two circuits of different self-induction, or phase-displacement, one shall be chosen as the working winding, and the other as starting winding. This is, of course, not the case—nor would it give grounds for a patent.

As a matter of fact, my patent does not speak of working or starting windings, but simply claims "that with single-phase motors having circuits of different phase-displacement, the self-induction of the circuit of greater phase-displacement shall be made smaller than the self-induction of the circuit of lesser phase-displacement.

This method of designing single-phase motors is certainly in direct opposition to all other methods, as Mr. Eborall clearly saw. For the purpose of obtaining large differences of phase, such methods always consisted in making the winding of small phase-displacement of small self-induction, and the winding of large phase-displacement of large self-induction.

For instance, consider fig. 1 of Mr. Brown's patent—the example cited by him. Obviously, the ring winding produces the greater phase-displacement, and the drum winding the smaller. But the former has 16 turns, and the latter 4 turns, that is, the winding of *larger phase-displacement* has the *greater self-induction*.

Alexander Heyland.

"Aluminium Conductors."

With reference to the relative advantages of aluminium and copper, the following statement shows briefly how matters stand at present in this country, and is a handy way of ascertaining the more economical metal to employ:—

The conductivity of aluminium is $\frac{6}{10}$ths (60 per cent.), and its weight $\frac{3}{10}$ths, that of copper. Therefore, for the

same resistance, the weight of aluminium will be $\frac{1}{6} \times \frac{3}{10} = \frac{1}{2}$ that of copper.

The lowest price aluminium wire can be obtained in this country at present is 1s. 7d. per lb. Therefore, with high conductivity copper wire at 9½d. per lb., the two metals cost exactly the same for the same resistance.

Copper wire at present costs rather more than 9½d. per lb., so that the balance is slightly in favour of aluminium for bare conductors.

It must be remembered, too, that its weight would be only half that of copper, so that for overhead work the supports would be cheaper.

The diameter of an aluminium conductor, as compared with copper (being for, say, a current of 250 amperes, 21·5 mm., against 16·5 mm.), quite excludes any chance of its adoption for insulated conductors.

F. E. A.

Measurement of the Internal Resistance of Accumulators.

In the article on "Measurement of the Internal Resistance of Accumulators," appearing in the ELECTRICAL REVIEW, of October 20th, page 623, there are two inaccuracies in the diagrams made by omitting lines in the engraving of my original figures. In fig. 2 there ought to be a connection between the positive pole of the cell under test and the looped line representing the connection between the two coils of the differential galvanometer. In fig. 4 the terminals of the galvanometer should be joined, one to the positive pole of the cell under test, the other to the junction of R_1 and R_2.

E. C. Rimington.

[We regret the unfortunate slips to which our correspondent draws attention; the correct figures are reproduced below.—EDS. ELEC. REV.]

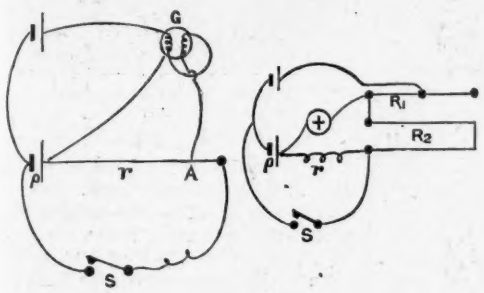


FIG. 2.

FIG. 4.

WHAT IS A "FACTORY?"

THE definition of this term has become shrouded with considerable importance ever since the Workmen's Compensation Act came into force, and, in a large number of cases arising under that Act which have reached the Court of Appeal, its true interpretation has come either directly or indirectly before their Lordships' notice. Among the many difficulties which have beset the interpreters of this statute—we include in this term arbitrators, County Court judges and the members of the Court of Appeal—none has been forced into a position of greater prominence than the exact delimitation of the scope of the Act. With a view to marking out that portion of our industrial community within which employers have to become universal insurers, the Legislature has endeavoured, by vague references to older statutes, to define the term "factory" so as to include industries which involve the employment of skilled labour in places utterly unlike anything that we have hitherto been accustomed to regard as an orthodox factory. A study of the cases which have been reported in the Law Reports reveals the fact that, so far, this attempt has met with signal failure, and a recent case in the County Court, to which we will presently refer, serves to show the immense importance of the distinction between work in a "legal factory" and employment outside the "walls" of that extraordinary institution.

Before referring to any of the decided cases, it may be as well to direct attention to that part of the Workmen's Compensation Act which is supposed to have correctly defined the scope of the statute. By Section 7 the term factory includes "every dock, wharf, quay, warehouse, machinery, or plant, to which any provision of the Factory Acts is applied by the Factory and Workshop Act, 1895 [and also every laundry worked by steam, water, or other mechanical power]. By Section 23 of the Factory Act, 1895, certain specified provisions of the Factory Acts (*e.g.*, the provisions with respect to accidents and the power to make orders with regard to dangerous machines) shall have effect as if every dock, wharf, quay, and warehouse, and, so far as relates to the process of loading therefrom or thereto, all machinery and plant used in that process were included in the term factory. The term also includes any premises on which machinery worked by steam, water, or other mechanical power, is temporarily used for the purpose of the construction of a building, or any structural work in connection with a building. The Workmen's Compensation Act also makes certain provisions as to who shall be considered the "owner" or "occupier" of such a factory. Such are the statutory declarations with regard to a "factory." Comprehensive as they may appear, their elucidation is in no way rendered less difficult by the fact that compensation is only awarded to a workman who suffers from injury arising "out of and in the course of" his employment, "on, in, or about" the factory.

The case of M'Nicholas *v.* Dawson (1899, 1 Q. B. 772) gives us some idea of the difficulties which are likely to arise. There a workman was employed in a shed to look after a steam engine connected with a mortar pan for mixing mortar for use on a building near at hand. When thus employed he sustained personal injuries through an accident. The question arose whether he was employed "on, in, or about a factory" within the meaning of the Act, as the building in which the engine was working was less than 30 feet in height. It therefore became necessary for the Court to scrutinise the language of the definitive section most carefully. By the Factory and Workshop Act, 1895, Section 23, a number of provisions are applied to a number of things that, for the purpose of the Section, are treated as factories, which would not otherwise be so. Amongst these are the provisions of the Act with respect to the power to make orders as to dangerous machines, and these are to have effect as if any premises on which machinery worked by steam, water, or other mechanical power is temporarily used for the purpose of the construction of a building or any structural work in connection with a building, were a factory within the meaning of the Act. For this reason the premises in question, upon the facts found, were made a factory by the Act of 1895. And as was pointed out by Lord Justice Romer in the course of the argument, the engine, if it came under the heading of "dangerous machinery," was itself a factory within the meaning of the Act, thus giving us a factory within a factory.

The above case is a fair specimen of the class of problem which the Court of Appeal has been asked to solve in connection with the Workmen's Compensation Act, which has been called, by more than one judge, "a veritable Chinese puzzle." As we have pointed out, however, the exact definition of the word factory is not the only difficulty which besets the adventurous mind that endeavours to interpret the Chinese puzzle. The words "arising out of and in the course of his employment" have cropped up in more than one case. Acts done in a sudden emergency have been held to be in the course of the employment—while, as soon as a servant takes his mind off his master's work to embark upon some frolic of his own, he travels beyond the limits prescribed by the Act; and thus, in the case of Smith *v.* the Lancashire and Yorkshire Railway Company, it was held that a porter who met with an accident when stepping on the foot-board of a train, in order to speak to a friend, was not entitled to compensation. Be it observed that we have no special reason to quarrel with these decisions. They are merely cited in order to give some idea of the countless points which might have been foreshadowed had the Bill, which became law in the summer of 1898, been subjected to further and more thorough Parliamentary criticism.

The next question which has forced itself into notice is, What is the meaning of "on, in, or about" a factory? *Tot homines, tot sententiæ* accurately expresses, not only what has

been the result of a year's administration of the Act, but what, in accordance with the ruling of the chairman of Appeal Court I. (Lord Justice A. L. Smith) must always characterise the interpretation of these words which are to be found in Section 7. "*Tot homines*" includes the numbers of our County Court Bench sitting in accordance with the provisions of the Act—"*tot sententiæ*," represents their findings upon points of fact, as distinguished from points of law, in respect of which they may be overruled in the Court of Appeal.

That the interpretation of these all-important words "on, in, or about," involves the decision of a point of *fact* as to which the opinion of a County Court judge is final and conclusive, may be gathered from the following words of Lord Justice A. L. Smith in Powell *v.* Brown (1899, 1 Q. B., 157):—"The question arises, what meaning is to be attached to the words 'on, in, or about?' It is obvious that the Legislature thought that the first two words were not large enough to cover all that they intended to include, and they, therefore, added the word 'about,' which is clearly an enlarging word. In my view that word means that the employment may be in close propinquity to the factory, and whether that was so in this particular case is a question of fact to be determined by the tribunal before which the claim comes. The judge, in this case, has found that the deceased was employed 'about the factory,' and this brings the case within the statute." It will be seen that this ruling, which we do not suggest is erroneous, casts a heavy burden of responsibility upon the County Court Judge. He, or the arbitrator appointed by him, has to decide every case upon its merits, without any reference to, and entirely independent of, his colleagues in other parts of the country, who may or may not take the same view of the word "about" that he does himself.

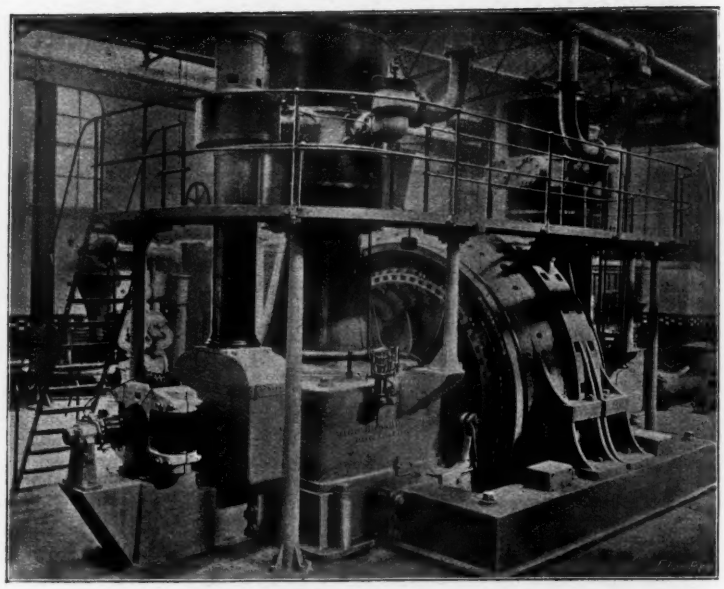
Up till quite recently the only reported cases upon this branch of our subject dealt with the accidents to carters at greater or less distances from the works or other premises of their employers. But a different—and, to electrical engineers—a very much more important case, came before his Honour Judge Addison on October 3rd at the Southwark County Court. There an engineer, named Belsey, sued his employers, Messrs. Sadler & Co., engineers, of Tooley Street, for compensation. It appeared that he had been injured, not upon their works, but at a customer's factory, where an hydraulic crane was in the course of erection. It was argued on behalf of the employers that inasmuch as the accident did not happen "on, in, or about a factory of which they were the occupiers," the claimant was not entitled to compensation. This view was adopted by his Honour Judge Addison, who said: "I come to the conclusion that the factory must be a factory of the undertakers or employers." We should note that, for the purpose of arriving at this decision, his Honour also held that the erection of a hydraulic crane was not an "engineering work." Should this decision be allowed to stand (his Honour having promised to give the claimant every facility for the purpose of lodging an appeal), it cannot fail to be received with lively satisfaction by electrical engineers and contractors, whose employment of outside workmen forms an integral part of their business. If a workman employed in another factory is disentitled to compensation, we may safely assume that those engaged for the purpose of laying wires in private houses may look in vain for relief under the Act of 1897.

Kingswinford.—The *London Gazette* contains the usual notice by the Rural District Council of transference of electric lighting powers (1898) to the Midland Electric Corporation for Power Distribution.

A 600-KW. INDUCTOR ALTERNATOR FOR SHEFFIELD.

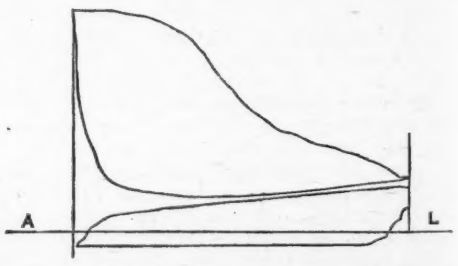
After hearing so much of the inductor type of alternator and its widespread use in Switzerland, it will doubtless interest our readers to know what is being done in this country with that type of generator.

The illustrations herewith represent a 600-kw. combined Raworth Universal engine and Mordey inductor alternator, constructed by the Brush Electrical Engineering Company, Limited, at their Loughborough works, and erected for the Sheffield Corporation in their lighting station.



600-kw. Inductor Alternator.—Back View.

If we are correctly informed this plant is unique, inasmuch as it is the only inductor alternator known to have been constructed for a frequency so high as 100 periods per second, and the Brush Company showed no little courage in undertaking the experiment with so large a machine in the face of the most pessimistic prophecies.



The plant ran its six hours' official test on August 9th last, and has been in regular service ever since. The results are not only far superior to the guarantees, but superior to the best expectations of the designers. The combined efficiency is, in fact, remarkably good, showing at the test, on non-inductive full load, fully 82¾ per cent., including excitation, when new and comparatively stiff; on one-third load the efficiency was 74 per cent.

Consistently with the high efficiency, the temperature rise is very low, the hottest part only rising 34° F. after six hours' run at more than full load—the maximum output during test being as high as 720 kw.

As will be seen from the illustrations, the rotor—which, as is well known, comprises nothing but a serrated fly-wheel without conductors or windings of any kind—is suspended

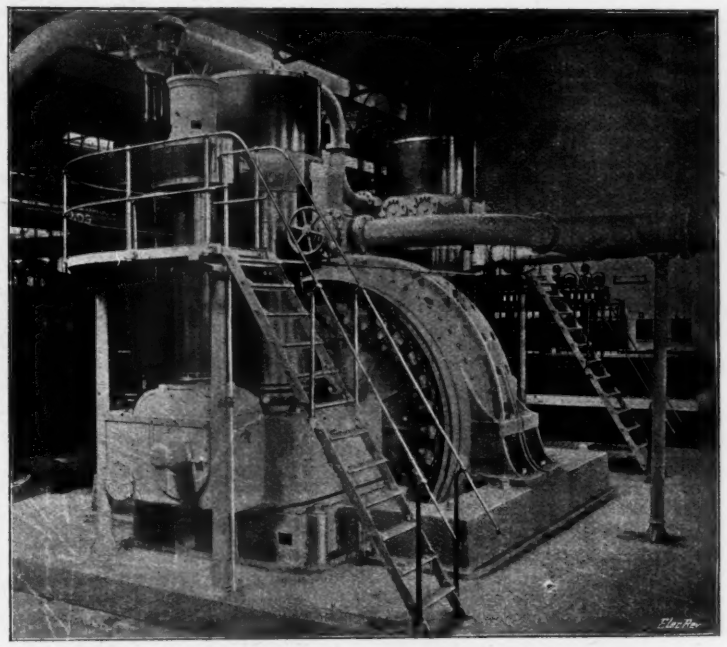
between the engine cranks. The stator conductors are well insulated solid rods of copper, passed through holes in the iron laminæ; the field is excited by a single coil, and the whole construction is so mechanically sound, that it approaches one's conceptions of an ideal dynamo. Now that the one point upon which purchasers were sceptical—namely, "efficiency"—has been effectively disposed of by actual results, and even at 100 ~, we shall be greatly surprised if this type of machine does not make great progress in the immediate future.

It appears to be almost generally admitted that the inductor is not the cheapest form of alternator that can be constructed for a given output at a given speed, but if the same efficiency and regulating qualities are demanded in both cases, the difference becomes unimportant, and in view of its obvious mechanical advantages, it is probable that its higher cost will no more prevent its adoption than the higher cost of direct-coupled dynamos has prevented their adoption in preference to belt and rope driving.

We understand that the Brush Company, who control the patents in this country, have on order a considerable number of these machines of large size, several of which are of polyphase type, and when the doubling of their heavy machine shop is actually completed, they expect to turn out a very large horse-power per annum in alternators.

The engines in this Sheffield set are also worthy of special note, as they are the largest "Universals" so far under steam, though several others will shortly follow. We are glad to hear that they are no less a success than the alternators.

The engine has been so frequently described, that our readers cannot fail to be more or less familiar with it, but we may briefly state that each crank is operated by compound cylinders arranged tandem, each cylinder is single-acting, and the two Corliss valves are between the cylinders, thus obtaining the shortest possible steam ports. The engine in question is of massive proportions. Each crankshaft, for instance, has a bearing next the rotor 13 inches diameter × 34 inches long, and whilst the makers are to be commended for their caution in being well on the safe side, we are not surprised that they now rate this plant at 750 KW. capacity. The speed is 200 revolutions per minute, and the running leaves nothing to be desired.



600-KW. INDUCTOR ALTERNATOR.—FRONT VIEW.

The steam consumption, calculated from the indicator diagrams, was about 27¼ lbs. per KW.-hour at full load (allowing 10 per cent. for clearance), and is well within the specification. It is also particularly good on light loads. The indicator card we illustrate was traced by ourselves from one of the actual cards taken at the official test.

Mr. Wm. Johnson, the engineer to the Sheffield Corporation, is as much to be congratulated upon his perception of the merits of this design of plant and his willingness to take some portion of the risk of trouble with such a new departure as the Brush Company is to be congratulated upon its unqualified success.

BUSINESS NOTICES, &c.

Books Received.—"Fire Tests with Treated Wood." London, 1899, The British Fire Prevention Committee. 2s. 6d.

"The Valuation of Gas, Electricity, and Waterworks for Assessment," by T. & W. Newbigging. Second Edition. London: Walter King. 5s.

Catalogues.—From the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, we have received an illustrated list of their direct current multipolar motors of several types.

A well printed and nicely illustrated list of M.P. type slow and moderate speed motors comes to hand from the British Thomson-Houston Company, Limited. The principal features in the construction of these motors, are shown by small illustrations of the various parts. A classified list showing capacity, weight, dimensions, &c., in table form, is given.

The General Electric Company, Limited, has issued a new price list of plain steel interior conduit with particulars and prices of bends, elbows, junction boxes, and other accessorial parts.

Messrs. O. Berend & Co.'s "E" list, just published, describes the "Prometheus" system of electric cooking and heating, combined with a three-contact and four-way system for the perfect regulation and adjustment of the current. Illustrations and prices are given of various cooking utensils such as kettles, saucepans, plate-warmers and radiators, &c. The Prometheus system of resistances is claimed to be a real step in advance, and a great improvement on the earlier systems of embedded corrugated wire resistances; it is said to be free from all those defects inherent to such systems which are stated to have so far retarded the general adoption of electricity for cooking and heating purposes, viz, cracking of the insulating materials due to unequal expansion and contraction of the embedded metal, short circuiting, and the great difficulty of repairing damaged goods.

The Prism Globe Company, Limited, is circulating a new catalogue of the Prism globes of various patterns and for various purposes. Some brief notes of photometric tests of the globes are given, also illustrations showing the Prism globes in use for street lighting.

Messrs. Gent & Co., of Leicester, send us a new catalogue of bells and telephones which has been made as concise as possible, consistent with the inclusion of all goods for ordinary requirements. Among the various articles shown by illustration, and priced, are pendulum, drop, and other kinds of indicators; iron-cased, water-tight, mining and other electric bells; then follow a large variety of sundry insulators, pushes and pulls of all patterns, fire alarms, electro-medical apparatus, hand, table and intercommunication telephone sets, &c.

A small booklet is to hand from the Synchronome Syndicate, Limited, of Gracechurch Street and Clerkenwell Road, in which some applications of the "Synchronome" system of electric time service are detailed, and a report on the system by Prof. Thompson given, as well as a number of photographs of important buildings where it is in vogue.

Change of Address.—Mr. Sidney à Court, A.M.I.C.E., has removed to 39, Victoria Street, Westminster, S.W., from Artillery Mansions.

The Copper Market in October.—Messrs. H. R. Merton and Co.'s statistical circular for the fortnight ending October 15th, to which brief reference was made last week, shows that the supplies of copper still fail to keep up with the deliveries, the fall in stocks during the fortnight being = 2,164 tons. This fall is, however, more than balanced by the shipments from Liverpool and Swansea to U.S.A. during the fortnight in question, the total shipments from these ports having been = 2,275 tons. Since June 1st, 6,926 tons copper has been transhipped to New York from Liverpool and Swansea, and this unusual feature of the market has helped to keep down European stocks. The full figures for the fortnight ending October 15th are:—Supplies, 8,670 tons; deliveries, 10,834 tons; stocks, October 15th, 26,164 tons. The shipments from outside countries during the fortnight have amounted to 1,434 tons, as against an average of 1,800 tons for the preceding 12 months. The price of G.M.B.'s has only advanced 2s. 6d. per ton, in spite of the fall in stocks, being £75 17s. 6d. on October 15th, as against £75 15s. on September 30th.

Electrical Wares Exported.

Week ending Oct. 25th, 1898.		Week ending Oct. 24th, 1899.	
Adelaide	Value £12	Albany	Value £277
Albany	121	Alexandria	15
Amsterdam	10	Amsterdam	110
Batoum	50	Boulogne	63
Bombay	105	Brisbane. Teleg. mat.	200
Brisbane. Teleg. wire	13	Buenos Ayres	3,639
Buenos Ayres	56	„ Teleg. mat. ..	100
Calcutta	657	Calcutta	553
Cape Town	176	Cape Town	236
Colombo	53	Christchurch	75
Copenhagen	400	Copenhagen. Teleg. cable ..	85
Durban	133	Durban	241
Hamburg	654	„ Teleg. mat.	189
Hong Kong	1,025	Fremantle	52
Limon	12	Gothenburg	12
Madeira	122	Hamburg. Teleg. mat.	200
Madras	19	Hong Kong	714
Malaga	22	Kobe	856
Marseilles	19	Lyttelton	24
Melbourne. Teleg. mat. ..	296	Melbourne	41
Odessa	70	„ Teleg. mat. ..	1,032
Ostend	30	Montreal	77
Otago	51	Nagasaki	13
Rotterdam	4,478	Ostend	28
St. Petersburg	175	Otago	75
Santos	120	Perth	137
Shanghai	200	Port Elizabeth. Teleg. wire ..	317
Singapore	25	Rio Janeiro	64
Stockholm	424	Rosario	858
„ Teleg. mat. ..	360	Rotterdam. Teleg. wire ..	29
„ Teleg. cable ..	432	Santa Cruz	35
Trinidad	36	Santos	134
Wellington	2,710	„ Teleg. mat.	190
Yokohama. Teleg. mat. ..	1,645	Stockholm. Teleg. wire ..	156
		Sydney	1,588
		„ Iron teleg. wire ..	204
		Trinidad	26
		Wellington	656
		Yokohama. Elec. cable ..	200
		„ Teleph. cable .. .	780
Total ..	£14,771	Total ..	£14,231

Foreign Goods Transhipped.

Durban. Telephones ..	Value	£43
New York. Elec. goods ..		450
Total		£493

Fire Prevention.—The British Fire Prevention Committee started its winter session last week, by arranging a private view of its testing station at Regent's Park, and showing a series of experimental tests with a concrete floor, with an iron safe, and with some wooden doors. The very numerous visitors were received by Mr. Sachs, chairman of the executive.

Intended Dividend.—The *London Gazette* contains notice of an intended dividend in the case of J. E. Stott, electrician, Huddersfield. November 3rd is the last day for receiving proofs. Trustee, Mr T. H. Kaye, 8, Princess Street, Huddersfield.

Klein Cooling and Condensing Plant.—The Corporation of Bolton have decided to adopt a Klein's patent fan water cooler at their electricity works for cooling the water requisite for condensing the steam from engines of 3,000 H.P. The fans and also the circulating pump are driven by electric motors, and the cooler is to work in conjunction with engines made by Messrs. John Musgrave and Sons, of Bolton. At the present time a surface condensing and Klein's open type cooling plant is in course of construction for The London & North Western Railway's Works in Crewe for engines of 800 H.P. to work in connection with electric lighting and power plant. The Prestwich County Asylum are now adopting Klein's jet condenser and chimney cooling plant for engines of 450 H.P. in conjunction with their electric lighting plant.

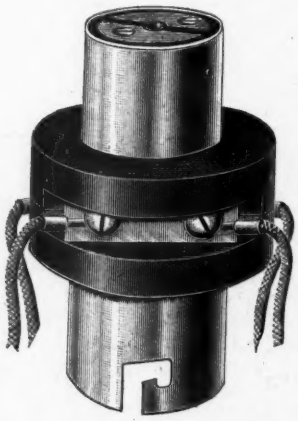
New Electric Car Works.—Rapid progress is being made with the extensive buildings at Hadley, near Wellington, for Messrs. G. F. Milnes & Co., of Birkenhead, for manufacturing electric tramcars and light railway cars. Houses are being erected for the accommodation of 550 workmen who will be employed at the new electric car works, which will cost over £100,000. The company will be able to turn out 700 or 800 cars per annum. Already sufficient orders have been booked to keep the men employed for over two years.

Niagara.—The Niagara Falls Power Company is about to erect several industrial buildings on its lands at Niagara Falls for the special accommodation of firms who desire to rent floor space and power. These buildings will be located near Echota. They will be built of brick and iron, and have slate roofs. Each building will be three stories high. Heretofore the manufacturing plants locating at Niagara have occupied great spaces of land and used a large quantity of power, but have employed comparatively few hands. The proposed structures are to cater to the manufacturing firms who use a small amount of power, but employ many hands. In connection with this announcement, it is stated that beginning about the first of the coming year, the Niagara Development Company, an allied company of the Niagara Falls Power Company, will commence selling houses and lots in the manufacturing district, thus giving operatives an opportunity to own their homes.

Last winter the great steel arch across the Niagara River, close to the Falls, over which the cars of the International Traction Company run, had its safety threatened by the immense ice jam that gathered in the gorge at that point. It will be recalled that the ice jammed high about the bridge abutments on both sides of the river until it was found necessary to blast it away several times. Some of the steel trusses of the structure were also bent by the ice. In order to prevent these alarming conditions in the future, protective walls of concrete rubble are being built about the abutments on both sides of the river. These walls are over 100 feet long, quite thick, and over 20 feet high, well calculated to withstand any pressure of ice that may in the future be brought to bear on them. In addition to this about 30 tons of new steel trusses are being inserted in the bridge to replace parts now deemed too light. The arch rises right from the water's edge, and therefore the danger from the Niagara ice jam, which is of wonderful extent and power, backed as it is by the water and ice that keeps pouring over the precipice.

Liquidations, &c.—A petition for winding up the Milner Portable Electric Battery Syndicate, presented by G. Trenam, 7, New Court, Lincoln's Inn, solicitor, a creditor of the company, will be heard at the High Court before Mr. Justice Wright on November 1st.

The Vetter Current Tap.—We illustrate below the Vetter current tap, which consists of a tapping plug and lamp socket combined, the fitting being attachable in the same way as an ordinary socket plug. The device is exceedingly simple, but it will be found of use wherever electric current is available for private lighting, as it is designed to facilitate the transmission of current to any desired point in the vicinity of the fixture, without the loss of the lamp at the point where the current is taken. As the name indicates, it "taps" the current, and does it in so simple a manner that a novice can use it without the slightest difficulty. The current tap is made in two styles, viz.: Parallel and Series. With the "Parallel" current tap, the procedure is as follows:—To obtain a droplight for the desk, place a Parallel tap in the wall bracket, replace the lamp and carry the conducting cords to the desk lamp. There will then be two lights instead of one. An electric fan can be



operated at the same time from the same tap, thus giving two lights and a fan motor from one outlet. A light can be carried to any part of the lathe, printing press, or wherever desired, by the use of the Parallel tap inserted in the ordinary hanging or fixture socket. The Vetter "Series" current tap provides a ready means to obtain the current for the head lamp, Galvanic or Faradic apparatus from the electric light fixture, using the lamp in the current tap to modify the current. Bicycle lamps operated by storage batteries, can be charged from any electric fixture on the direct electric current, by means of the Series tap, with a lamp placed in same. This speciality and also the "Universal" diagnostic lamp outfit is made by Mr. E. B. Meyrowitz, of New York.

Trade Announcements.—The Phodyne Electrical Company, Limited, has been formed for the purpose of carrying on business as electrical contractors. Mr. J. C. M. Stanton, M.I.E.E., is managing director. The offices are at 66, Victoria Street, Westminster.

Messrs. J. G. Childs & Co., electrical engineers, have removed from 24, Brewer Street North, to 145, Farringdon Road, E.C.

ELECTRIC LIGHTING NOTES.

Battersea.—The Vestry on Wednesday, in connection with the interim injunction obtained by the County of London Company restraining the Vestry from interfering with the mains in Trinity Road, decided to counterclaim for a writ of mandamus to compel the company to remove the mains.

Belfast.—The County Borough has entered into an agreement with the National Electric Wiring Company, Limited, of Faraday House, London, W.C., to instal the light free of initial cost to the consumer where the Corporation's mains are laid. The charge for the hire of the wires and fittings is 1d. per unit for the first hour's use of the consumer's maximum demand per day, and ½d. per unit for all used afterwards.

The Council has had under consideration the question of extensions

to meet the demand for electricity, and has decided to order additional plant at an early date.

Bonchurch.—The Parish Council has sealed its agreement with the Electric Light Company.

Bridgwater.—The report of Mr. W. H. Trentham, respecting the electric lighting of the borough, has been adopted by the Council, which has also resolved that the necessary steps for carrying out the scheme should be taken. In the report, Mr. Trentham recommended the adoption of the low pressure system, and gave it as his opinion that the Council would save £130 a year.

Cardiff.—The Board of Guardians has under consideration the question of electrically lighting the workhouse.

The Electric Lighting Committee is holding an inquiry into the causes of a recent breakdown of the public lighting, said to be due to water entering a street box.

The contract for lighting the Royal Hotel, which was awarded to Messrs. Edwards & Armstrong, will be carried out under the supervision of Mr. W. Leake, consulting engineer, of Manchester.

Cheltenham.—The Town Council on 23rd inst. agreed to apply for a provisional order to extend the area of electric light supply to the parishes of Charlton, Kings Leckhampton, Prestbury, Swindon, Bishop's Cleeve, Southam, Woodmancote, and Brockhampton.

Clacton.—The Council has decided to make application for a provisional order enabling it to supply the town with electric light.

Cleckheaton.—The General Purposes Committee of the District Council has appointed Mr. Alfred H. Gibbings, of Bradford, as electrical engineer, to prepare a scheme for the electric lighting of the town; the Council intends to apply for a provisional order in the next session of Parliament.

Douglas.—Prof. Fleming has presented a report to the Corporation on the subject of electric lighting. He was asked to report specially as to whether the town should lay down its own installation or take the supply from the Electric Tramway and Power Company, which offered exceptionally favourable terms, and he advised the Corporation to adopt the former course. The Lighting Committee of the Town Council has recommended the adoption of the report. In his report he says the company proposes to supply on the three-wire system, with 460 volts across the mains, the pressure to the consumer being 230 volts. He objects to this high pressure service because it prevents small consumers from using 5 and 8-C.P. lamps, such as would be used with great advantage and economy in boarding houses. It would cost the Corporation £10,000 to lay down mains and erect lamps, and to maintain an efficient independent staff, and for repairs there would be an annual outlay of £1,100 merely to become purveyors of electric energy which they would purchase in bulk at 3d. or 3½d. a unit. They would have to charge more than if they generated it themselves. The great success of the electric lighting industry in some towns, Prof. Fleming points out, has arisen solely from the fact that they have catered for the small consumer. In order that the enterprise might succeed, electric light must become the poor man's light, and not simply the light of the well-to-do. If the Corporation of Douglas bound themselves to purchase in bulk at a fixed price from a limited company, they seriously tied their hands in dealing with the price of supply, and might find in years to come that the financial condition would have been very different had they followed the now usual policy of becoming themselves the manufacturers and undertakers.

Ealing.—A partial interruption of the electricity supply took place on the evening of the 17th inst., lasting for 1½ hours.

Edinburgh.—An Edinburgh paper says that on 18th inst. the Bruntsfield, Morningside, Newington, Pleasance, Inverleith, Murrayfield, and Portobello districts of Edinburgh were plunged into darkness owing to a fire at the Dewar Place electric lighting station. "About half-past nine the wires at the high tension switchboard in the basement of the building fused, and flames and continuous explosions for a time made the mishap assume a serious character. . . . The fire was soon extinguished, but the destruction of wires and other plant effectually stopped the supply of light to the high tension system for the night. The officials have not been able to discover the cause of the conflagration, although the supposition is that it arose through the fusion of some of the wires." Matters were soon put right, and the supply was turned on again at two o'clock next morning.

The new electricity works at M'Donald Road was formally opened on Monday last. This station will ultimately have a capacity of 30,000 H.P., of which over 1,200 H.P. is already installed. It was remarked that all Prof. Kennedy's original predictions regarding the future of the undertaking had been fulfilled. Bailie Mackenzie, convener of the Electric Light Committee, who had a large share in the successful accomplishment of the work, would only take credit for the fact that he never interfered with the engineers in the details of their work—in our opinion a most praiseworthy distinction.

Elland.—The District Council has resolved that an application be made to the Board of Trade for a provisional order for electric lighting in the district.

Falkirk.—The Edmundson's Electricity Corporation, Limited, has approached the Town Council with a view to making an agreement with the Council for the electric lighting of the town, subject to purchase after 14 years.

Ham.—The District Council is considering a communication from the Kingston Corporation, in which the latter puts forward proposals for the supply of electricity in the Council's district, subject to the approval of the Board of Trade.

Heaton Norris.—The Council has agreed to transfer its electric lighting order to the Manchester Corporation as soon as the approval of the Board of Trade has been obtained. Arrangements have also been made with the same corporation regarding the tramways.

Jarrow.—The Town Council has received a letter from an Electric Syndicate with reference to the supply of electricity to the district, offers for which have already been made by the Walker and Wallsend Gas Company. The committee recommended the engagement of an expert to advise the Council as to the terms offered, to which the Council agreed.

Lanark.—The Burgh Commissioners on Monday last resolved to approve of the electric lighting scheme of Messrs. Hunter & Jack, electrical engineers, Glasgow; to obtain a provisional order, and to raise a loan of £5,000 to carry out the work.

Leek.—The District Council has applied to the Board of Trade for a provisional order authorising the Council to supply electricity within the area of their district, pursuant to the powers and provisions of the Electric Lighting Acts.

Leicester.—The Council on Tuesday had under consideration the recommendation of the Electric Lighting Committee to borrow an additional sum of £100,000 for electric lighting purposes.

London, E.C.—It appears that the question of lighting London Bridge by electricity has been frequently discussed by the Bridge House Estates Committee, but the structure has to be repaved in 18 months' time, and the matter stands deferred until then.

The Local Government Board has sanctioned the loan of £14,680 for the Shoreditch Vestry's electricity works and wharf, for 50 years, at the rate of 3¼ per cent.

Manchester.—At a meeting of the City Council on Wednesday complaint was made of the delay in the delivery of a 2,500-H.P. generator required for the generating station in Dickinson Street. The Electricity Committee's action in ordering generators of such magnitude was objected to, some members expressing their belief that an accident to one of them would be attended with disastrous consequences. The chairman of the Committee, however, Mr. Alderman Higginbottom, said the Corporation had already one 2,500 H.P. generator running with perfectly satisfactory results. It had for a fortnight past taken the whole load of the main generating station, and no accident could by any possibility happen to it. The new generator was expected to be running in another month. The citizens, therefore, need have no fear about the constant supply of the electric current during the winter months. The practice of using such large units, Mr. Higginbottom added, was found, not only in Manchester, but on the Continent and elsewhere, both economical and safe.

Millom.—The District Council has resolved to oppose an application of the Northern Counties Electricity Company for a provisional order for the electric lighting of the town.

Northfleet.—The District Council has rejected the recommendation of the Works Committee, that the Council should apply for a provisional order for electric lighting.

Paddington.—The Vestry has sealed an agreement with the Metropolitan Electric Supply Company embodying the terms arrived at in July last, according to which the company obtains the consent of the Vestry to lay a conduit through the parish of Paddington.

Peterborough.—The Town Council on Friday last accepted the tender of Messrs. Main, Kendall & Main, of Loughborough, for the erection of the buildings for the electricity works at a cost of £2,334 8s. 4d.

Pwllheli.—The Town Council on Tuesday last resolved to apply to the Board of Trade for a provisional order for electric lighting.

Redruth.—At a meeting of the ratepayers last Friday, it was resolved that the Council should not adopt a municipal scheme of electricity supply, but should open negotiations with a company on the best terms obtainable.

At a special meeting of that Council on Monday last, it was accordingly resolved to re-open negotiations with Edmundson's Electricity Corporation.

St. Asaph.—The question of electric lighting has been discussed by the Parish Council, but no step was decided upon.

South Shields.—The new "Readhead" wing of the Ingham Infirmary, which was opened on 14th inst., is lighted throughout by electricity, and the contractor, Mr. James T. Dagleas, has secured the contract for lighting the whole of the old building. The contract for the complete electric light installation at the South Shields Theatre Royal has also been given to Mr. Dagleas.

Swinton and Pendlebury.—The District Council last week had under consideration a report of Mr. C. Hopkinson, of Manchester, on the subject of electric lighting, for which a provisional order has been obtained.

Tewkesbury.—The District Council has appointed Messrs. Christy Bros. to give expert advice as to the installation of electric light, &c., at a fee of £15 15s.

Twickenham.—Application is being made to the Board of Trade by Edmundson's Electricity Corporation for a provisional order embodying powers to supply electricity in Twickenham and Teddington. If successful, the works will be erected by Edmundson's and transferred to a limited company, from which the District Councils concerned will have the power of purchasing the undertaking after a term of years.

Weybridge.—The District Council is considering the proposal of the Urban Electric Supply Company, Limited, to apply for a provisional order for electricity supply in the district.

Withnell.—The District Council of Withnell, near Chorley, Lancashire, is considering a scheme for the supply of electricity to the district.

Wrexham.—A Local Government Board inquiry was held last Friday by Mr. H. H. Law, M.Inst.C.E., for the purpose of receiving evidence regarding the application of the Town Council for sanction to borrow £20,000 for purposes of electric lighting, with other loans. The town clerk gave particulars as to the way in which it was proposed to expend the money in the construction of the works, &c.—Mr. W. H. Trentham, of London, who prepared the report on the proposed electric lighting station, &c., for the Town Council, gave details as to the way in which the works were to be constructed, and the machinery to be used. Provision would be made for 27 arc lamps for public lighting, and it was believed that there would be sufficient private customers to ensure a profit on the outlay from the very first year.—The inspector said his experience was, that in a general way it took from two to three years before these undertakings began to pay their way.

Yeadon.—The District Council last week received a letter from the Board of Trade pointing out that the Council had taken no steps to carry out their obligations under the electric lighting order granted to them in 1894, and in such circumstances it devolved upon the Board to determine whether the order should be allowed to remain any longer in force. The Council engaged Mr. Enwright, London, to advise as to the best means of carrying out the order, and the clerk was instructed to acquaint the Board of Trade with this fact.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Aberdeen.—The Tramway Sub-committee, in view of the narrowness of St. Nicholas Street, has agreed to abandon the proposal to lay a double line of tramways in St. Nicholas Street. It has, however, agreed to recommend a double line from Castle Street, by way of Justice Street and Constitution Street, across the Links to the Bathing Station, the line to be electrically equipped. Another resolution arrived at is to construct a single line in continuation of the Bridge of Don section to join the light railway to be erected by the Seaton Brick and Tile Company.

Adlington to Whittle-le-Woods.—At a meeting of the Chorley Rural District Council last week the clerk said, in reference to the proposed electric tramway from Adlington to Whittle-le-Woods, that they had no legal standing in the matter of the main roads, which were entirely in the hands of the County Council, though the tramway could not be laid through their district without the consent of the Rural District Council. Under such circumstances they could only give their consent to the undertaking.

Birkenhead.—At Wednesday's Council meeting a resolution was submitted for confirmation as follows:—

That tenders be invited for the supply and delivery of 13 single-deck and 31 double-deck electric motor tramway cars, in accordance with the specifications, conditions, and form of tender prepared and submitted by the borough engineer and electrical engineer.

Bolton.—A portion of the Bolton and District Electric Tramway system is now complete, and a formal opening of two sections before the present Mayor's term of office expires is contemplated. The routes to be thrown open to traffic in the first instance are those of Tonge Moor and Great Lever. The lines only await the Board of Trade inspection.

Bradford.—The Tramways Committee is recommending the Council to apply for powers to construct tramways from the junction of Bolton Road and Idle Road, along Idle Road to Thackley, and from Wakefield Road, Tong, through Hunsworth, to the junction of the Leeds and Whitehall Road at the Halfway House, Birkenshaw. It was decided to request the Electricity Committee to proceed with the laying of the cables necessary for the working of the proposed new tramways to Lidget Green and Whetley Hill, the Thornbury extension, and the light railway to Stanningley.

Brighton.—On the advice of the Tramways Committee, the Council has decided that the necessary powers for the purchase of land for the erection of an electrical power station and the laying down of mains, should be included in the Tramways Bill.

Chester.—When the question of tramway municipalisation came up last week, Mr. James Frost wished to have an undertaking that the trams would not be worked by the overhead trolley system of electric haulage before he gave his vote. Mr. Churton said no such undertaking could be given. The motion was simply to give notice of purchase, and the method of haulage would be a question for future consideration. He was of opinion that the overhead system would be the most economical. The motion was carried by 19 to 10 votes, and it was referred to the Local Government Acts Committee to consider whether a provisional order or an Act of Parliament should be applied for to give the Corporation full powers.

Coatbridge.—At the last Town Council meeting a letter was read from the British Electric Traction Company, who applied to Parliament last session under the Light Railways Act for an order to construct a railway from Coatbridge to Airdrie, but which was rejected, owing to it being brought up under the wrong Act, offering to take up the tramway scheme in the burgh. It was decided, however, as the Council is involved in the joint municipal scheme with Airdrie Town Council, to reject the offer.

Dublin.—The Tramway Company have now practically completed the erection of the overhead wires from Parliament Street through Capel Street and Upper and Lower Dorset Street, to Botanic Avenue, alongside the river Tolka. Only the short crossing at Frederick Street remains to have the overhead wires constructed. The existing electric line will bring cars from the Pillar through Frederick Street to Drumcondra. It is expected that the whole of the work will be completed in less than a month's time.

On 18th inst. the new electric tram service was opened on the Northern line of quays between O'Connell Bridge and the Phœnix Park, so that passengers are now carried by electric traction direct from Westland Row to the Park.

East Ham.—The *London Gazette* (October 24th) contains notice of the application of the East Ham District Council to the Board of Trade for a provisional order for the construction of certain specified tramways, and for other incidental powers.

Electric Traction on the Metropolitan Railway.—In the House of Commons on Monday Mr. Ritchie informed Mr. Weir that the necessary plant for introducing electric traction on the metropolitan underground railways between Earl's Court and High Street, Kensington, had been constructed, and he understood that an experimental train would be run during the early part of November. He could not say when electric traction would be introduced generally. That would depend, of course, upon the result of the experiments.

Glasgow.—The Corporation Tramway Department has officially reported upon the collision of two electric cars in Mitchell Street on Tuesday last week. It is stated that in trying to prevent a slight collision with a lorry, the motorman lost his presence of mind, with the result that the car got beyond control and ran down the hill at a rapid pace, eventually colliding with another car. The damages to the car were very slight, and personal injury was also small. The hand and electric brakes were both found to be in excellent order; in fact, the whole car was reported as in perfect condition, both electrically and mechanically. In view of the attention which is now being paid to the subject of car control in several cities where mishaps have been somewhat frequent, we quote the following from the report:—

"In addition to brakes, if the motorman had not lost his head, he could have reversed his handles, and so, by throwing it into power, have caused the car to come to an abrupt stop. The different methods of stopping a car on an incline are:—

1. The hand brakes which operate by placing an iron block against each wheel.
2. The brake connected with the motors which, by a reversion of the controller handles, acts upon the axles of the driving wheels until they are skidding.
3. The dropping of prepared sand upon the track.
4. By reversion of a special handle, the motors can be brought into action to change the direction of the car.

In addition to the ordinary kind of hand brakes, similar to those on the horse cars, and which are powerful enough to control the cars on the steepest hills we have, if the rails are not very greasy, the electric cars are fitted with an electric brake, which consists of an arrangement on the controller, whereby the driver, by moving the handle in the opposite direction to that which puts on the power to drive the car forward, alters the connections of the motors, so that they act as dynamos, and generate current, which is passed through the resistances on the car, and thereby checks the speed by work done in heating these resistances, and the driver can stop the car altogether by altering the position of the handle. The electric brakes are absolutely independent of the trolley current, and it does not matter whether the trolley is on or off, for they can always be applied. In addition to these two means of breaking, so long as the trolley is on the wire, the driver can, by reversing the small handle alongside the big one on his controller, turn the power on and drive the car backwards, being able thereby to stop the car, even on the steepest hills. All that is required is that a driver should never lose his head, and always keep control of the speed of his car."

A local paper says that the Corporation Tramways Committee has agreed to recommend that the offer of the National Conduit and Cable Company, London, for the underground cables required for the extensions of the trolley system, be accepted. The amount of the contract is about £150,000.

Greenock.—The heads of conditions under which offers for leasing the tramways within the burgh of Greenock may be made were further considered at the Police Board last week. The several

clauses were discussed at considerable length, and numerous alterations were proposed; but the conditions generally were passed without important additions or deletions. Regarding the rates for electricity for the line, the electrical engineer (Mr. Fedden) stated that they would pay the Corporation very well. It was decided to remit the adjusted heads of conditions to the Law and Finance Committee, with power to advertise for and receive offers for the line.

Croydon.—Mr. Monkhouse advised the Tramways Committee that although there is no engineering difficulty in laying down the underground conduit system for a short length in the centre of town, such a dual system would necessitate an increased expenditure, and a service which, in its working, would not be so satisfactory as a continuous service of overhead traction. He recommended that the general principle of one system of overhead electrical traction be adopted. With regard to Mr. Monkhouse's report in favour of the proposal that the line should be leased to the British Electric Traction Company, subject to the contract price with the British Thomson-Houston Company for equipment being satisfactory to the committee, the committee say (according to an exchange) that they are still of the opinion that the best practical way of dealing with the tramways, after acquisition, is to lease them for 30 years, subject to power of determination at recurring periods of five years, upon the terms as contained in their report of May 26th, and they recommended accordingly. The Council has adopted this report.

Halifax.—Mr. A. P. Trotter held a Board of Trade inquiry on 18th inst. with regard to an application by the Corporation for sanction to borrow £49,217 for the purposes of the Corporation electric tramways. The town clerk, Mr. K. Walton, said the site of the new tramway depôt had an area of 4,500 yards. The total cost of the depôt, including the site and manager's house, was estimated to be £10,686 17s. 9d. Then £6,500 was required for the equipment of 13 miles of tram lines in the borough, and £18,000 for car bodies equipped complete, at a cost of £600 each, the remaining £3,600 being for sundries. The Inspector asked what guards had been provided for the new cars. The town clerk replied that the Corporation had got the best known guards. They would be happy to provide the cars with any guard that might be better known and more effective. The town clerk asked that, with regard to the repayment of the loan, 40 years be allowed for buildings, 30 years for permanent way, and 20 years for electrical equipment and cars. The Inspector said he would report to the Board of Trade.

Hastings.—By 23 votes to 9, the Town Council has approved of Mr. Murphy's scheme for laying electric tramways in the borough. The promoter pays £5,000 toward certain street improvements, and £50 per mile for wayleaves for the first five years, and £75 per mile afterwards.

Huddersfield.—The Corporation has just placed contracts for various masonry, painting, carpentry, and other work for the new generating station at Longroyd Bridge.

Lancaster and Morecambe.—The Morecambe District Council has under consideration proposals of the Lancaster Town Council for the acquisition of the joint working of the Lancaster and District Tramway Company's undertaking. A sub-committee has been appointed to deal with the matter. The scheme includes the substitution of electricity for horse traction.

Leeds.—Mr. Trotter visited Leeds on behalf of the Board of Trade on 19th inst., and inspected the Chapeltown and Headingley line, on which it is proposed to run electric cars, and the power station. The Board of Trade Inspector expressed his satisfaction with what he had seen, and the line will doubtless be passed for traffic in due course.

Limerick.—Last week a meeting of the Corporation was held to approve or disapprove of the scheme of the Limerick Electric Tramway Company, Limited. After discussion the matter had to be adjourned for a week. The proceedings were followed by hostile demonstrations, which prove that at Limerick to resort to fisticuffs is regarded as the best way to settle the question from the opposition's point of view. The Mayor and certain Councillors had to be escorted home by watchmen with drawn staffs.

Liverpool.—The Council has, by 48 to 31, rejected tramway No. 40 mentioned last week; Nos. 41 and 43 were approved, and, after further matters had been considered, it was resolved that the Tramways Committee be authorised to reconstruct the lines, for electric traction, from the Old Haymarket, along Victoria Street and North John Street, to Lord Street, at an estimated cost of £4,284 for permanent way and paving, and £729 for overhead electrical equipment.

Lowestoft.—The Council last week received a deputation from the Drake & Gorham Electric Power and Traction Company, Limited, who discussed the proposed electric tramway to be constructed from the Royal Plain, Lowestoft, northward, and also the modification of the route of the light railways already approved by the Light Railway Commissioners, to be constructed from Royal Plain southward.

Councillor Jones desired to ask if the promoters would pay a rental for the use of the roads, instead of the share of the dividends arranged to be paid.

The General Purposes Committee recommended that the electric tramway to the North Royal Plain should run along London Road and High Street, and outside the borough boundary, and go to Blundeston and Lound, the line to Blundeston to go by Yarmouth so far as possible. With regard to the route of the light railway authorised south of the Royal Plain, the Committee referred that matter to the Council for their decision.

Alderman Jefferies said that at the Committee meeting it was felt that to go over the old main line would invite possible opposition, so that they recommended that the line should go to Blundeston and Lound. That route would be very helpful to Lowestoft, and if the line could be taken to Lound it would be of further advantage; but the Committee would also be pleased if the company could carry the line to somewhere near Somerleyton Park. If the Great Eastern Railway would give them the line from Corton, Hopton and Gorleston, and the Light Railway a line which would not be in opposition to that route, they would be thankful, and the action taken would not be likely to create opposition on the part of the Great Eastern Railway.

A discussion *re* route followed; 14 voted in favour of London Road, and 6 against.

Mr. Albright then asked the Council not to insist upon the company going to Lound at present. They would go to Blundeston. He suggested that the Corporation should apply for the Bill, the company paying the cost. If the Corporation undertook to do so they would be more likely to get the Bill through, whereas the company might encounter some opposition.

Mr. Drake said they had heard that if the Light Railway Company brought forward another scheme the Great Eastern Railway would oppose it, whereas if the Corporation promoted a scheme the company would not oppose it.

Musselburgh.—The Town Council on 16th inst. agreed to accede to the conditions laid down by Messrs. Drake & Gorham for the construction of an electric tramway between Musselburgh and Portobello. The terms permit of the Corporation buying over the tramway as a going concern at the end of 14 years, with four years' profits added in name of goodwill.

Preston.—The Corporation have decided to follow the expert opinion recently obtained, and to seek Parliamentary powers in the next session to carry out an electric tramway scheme for the borough.

Rawmarsh and Rotherham.—Both the Rotherham Corporation and the Rawmarsh Urban District Council are taking the preliminary steps to obtain powers from Parliament to enable them to lay down electric tramways.

Ryde-Seaview.—Owing to the strenuous opposition of residents the Light Railway Commissioners have refused to grant an order for an electric railway from Ryde to Seaview (I.O.W.).

Southend-on-Sea.—The Council's Light Railways Committee has recommended that the overhead electric trolley system be adopted, and that the surveyor be instructed to prepare the necessary plan.

Surrey.—An important electric tramway scheme for the northern part of Surrey has been elaborated by the Highways Committee of the Surrey County Council. It will be submitted to that body on November 14th, with a recommendation that application be made to the Light Railway Commissioners to obtain the necessary powers. The scheme includes 29 miles 2 furlongs of line, and it is announced that this is only the first part of a scheme for the whole county, which will be hereafter elaborated. The scheme includes lines connecting Hammersmith Bridge with Barnes, Mortlake, and Richmond, and several lines in the latter borough; a line from the London county boundary at Wimbledon Common, passing over Kingston Hill to Kingston; lines connecting Tooting Junction with Mitcham, Carshalton, and Sutton, approaching Croydon Urban boundaries at several places; and an extension from these lines by two routes to Raynes Park, through Wimbledon and through Merton. From Raynes Park the lines will pass across country to New Malden, thence onward to Kingston—where it will throw a branch northward towards Richmond, as far as Ham Common—and so from Kingston through Surbiton, with several subsidiary routes, to Ditton. A daily paper remarks that the local authorities in several of the places affected have proposals of their own already in hand, and there may be a good deal of clashing, though in other cases, notably at Richmond, a desire has already been expressed to work with the County Council.

Swansea.—The British Electric Traction Company, in view of their recent application to extend their tramways in Swansea under the Light Railway Act, and their failure to get the order granted, have written to the Swansea papers explaining their position and intentions with regard to the matter. The letter says that the Mayor of Swansea offered, as his only apparent reason for opposing the company, his belief that they were not sincere in their proposals. The company, in the letter, reply to this by pointing to the £100,000 now being spent in the town to electrically equip the tramways. The letter goes on to say that, should the Corporation intend to carry out the extensions themselves, they could only do so within the borough limits. The fact of their going outside the borough would imply that there would be two authorities owning the lines, seeing that the outlying portions would be under the control of the Glamorganshire County Council. The company state that it is not their intention to pursue the matter, in consequence of the fact that, owing to their failure to secure the extensions under the Light Railway Act, all hope is excluded of the Corporation giving their consent under the Tramways Act.

Warrington.—The Town Council has this week decided to apply to the Board of Trade for a provisional order for the construction of electric tramways within the borough. The main streets are excessively narrow and crowded. Our correspondent says that at present it is impossible for an ordinary omnibus to approach the centre of the town except at a crawling pace.

Worcester.—The Electricity Committee has decided to recommend the Council to acquire and work the city tramways at the expiration of the company's lease.

TELEGRAPH AND TELEPHONE NOTES.

Cardiff Telephones.—At a meeting of the General Purposes Committee of the Cardiff Corporation on Monday, the Mayor said that there was no prospect of the Corporation being allowed to buy out the local telephone system, because the Government expected to be able in 25 years to acquire the telephonic system throughout the country. In a recent interview granted by the Duke of Norfolk to the Mayor, the member for the borough, and the town clerk, the Postmaster-General had stated that if the Corporation would lease the whole of the local Post Office system for a period not exceeding 25 years, a license would be granted to them. Penarth, Barry, and neighbouring places would be included. The whole matter will come up for consideration at an early meeting of the Corporation, for which the town clerk was instructed to get details of the scheme.

Colombia Cables.—Reuter's New York agent said, on the 23rd inst.:—"A censorship has been established at Panama and Buenaventura on all telegrams for Colombia, the Government of which advises the cable companies to refuse messages for Cartagena, Barranquilla, Cucuta, Ocana, and Bucaramanga, as the lines to these places will probably be down for a long time."

The Iceland Cable.—On page 638 of our last issue we reproduced a paragraph from the *Financial Times* referring to a cable to Iceland, in which it was stated that the cost is estimated at 10,000,000 kroner. We understand that this is evidently an error, and that probably 2,000,000 is meant instead of 10,000,000.

Manchester Telephones.—The City Council was asked at its meeting on Wednesday, on the recommendation of a special committee, to endorse the New Mutual Company's application for a license. This company was started with a guarantee fund, about two years ago, and just when it appeared likely to get its license—having the support at that time of the Corporation—the announcement was made than no more licenses would be granted by the Postmaster-General to private companies. The New Mutual Company's proposed terms are £6 6s. a year for an unlimited service. Shareholders would receive an advantage upon this rate, proportioned to the amount of the investment in the company. For limited user the charge would be £2 17s. 6d., and 1d. per message. It is also considered that a minimum inclusive charge of £4 10s. for 400 messages would suffice, to commence with, for limited user, as an alternative to the preceding offer. The company propose to transfer their business to the Corporation, or the Post Office, if at any future time either of them desires to take over the same, on repayment to the company of capital expended, with 5 per cent. interest, or at a valuation by arbitration. They ask for a license to extend over 21 years. It should be stated that the special committee of the Corporation by whom the lengthy negotiations with the National Company have been conducted were by no means unanimous in their support of the New Mutual. A large section both of the committee and of the City Council would prefer a municipalised telephone service. They were able on Wednesday to persuade the Council, as an alternative to the recommendation to support the New Mutual, to ask the committee to reconsider the subject, to consider the question of a municipal license, and to prepare a full report and recommendations for the Council.

Norfolk Music Festival and Telephones.—During the Norfolk and Norwich Triennial Festival week a connection by telephone was made between the St. Andrew's Hall and the Norfolk and Norwich Hospital and the Institute for the Blind in Magdalen Street, Norwich. The necessary work and the provision of the apparatus was done gratis by the Norwich Mutual Telephone Company. There were at times as many as 16 receivers being used at the hospital, the wires being of such a length that they might be changed from bed to bed.

The Pacific Cables.—In the House of Commons on 19th inst. Mr. Hogan asked the Secretary for the Colonies whether he was in a position to report any effective progress in the negotiations for the construction of the Pacific cable from Canada to Australia, or of the proposed alternative cable from South Africa to Australia. Mr. Chamberlain, in reply, said an arrangement has been arrived at with the colonies interested in the Pacific cable that the elaboration of the scheme, and the management of any line that may be decided on, should be entrusted to a board of eight members sitting in London. Her Majesty's Government are to be represented by three members, including the chairman, Canada by two members, and Australia and New Zealand by three. The Dominion Government have appointed the Earl of Aberdeen and Lord Strathcona to represent them, and the Australian colonies and New Zealand have nominated the Agents-General for New South Wales, Victoria, and New Zealand as their representatives. I am in communication with the Chancellor of the Exchequer and the Postmaster-General as to the nomination of the representatives of Her Majesty's Government, and I hope that the board will be constituted and in a position to meet next month, when the Agents-General for Victoria and New Zealand, who are now in the United States, have returned. I am informed that the Eastern and Eastern Extension Telegraph Companies have proposed to lay a cable from South Africa to Australia; but I have not learned that the colonies have yet come to any decision on this proposal.

The Telegraph in Central Africa.—According to the *Daily Chronicle* Brussels correspondent, the *Mouvement Géographique* says that, owing to the unsettled condition of the country between Tanganyika and Manyema, the telegraph expedition under the charge of Mr. Mohun, an American, has been unable to commence operations in the basin of the lake. The expedition is bearing in a westerly direction, and in June last was about to erect the first telegraph pole at Lungula, so as to continue work in the direction of Kasongo. The same authority says that communication between the Zambesi and Lake Nyassa is slow and difficult.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Bilbao-Falmouth	... Oct. 12, 1899	... Oct. 19, 1899.
Cayenne-Pinheiro	... Oct. 11, 1899	... ...
Corea-Japan	... Aug. 7, 1899	... ...
Gibraltar-Tanger	... Oct. 19, 1899	... ...
Jamaica-Colon	... June 30, 1899	... ...
Latakia-Cyprus	... June 20, 1899	... ...
Para-Maranham	... Oct. 20, 1899	... ...
Trinidad-Demerara (1871 original)	Oct. 20, 1899	... ...
Do. do. (1891 duplicate)	Oct. 6, 1899	... ...
Landlines.		
Lines from Haiti to Gonaives, Gros Morne, Port de Paix, Plaisance, Cape Haitien, Port au Prince to Miribalais and Jacmel ...	... Aug. 18, 1899	... ...
Communication with Mafeking	... Oct. 14, 1899	... ...
Nicaraguan Government line to Bluefields destroyed	... Oct. 6, 1899	... ...
Communication with interior of Venezuela	... Sept. 23, 1899	... ...
Landlines of Yucatan (Mexico)	... Oct. 21, 1899	... Oct. 22, 1899
Communication with all offices beyond the Orange River	... Oct. 18, 1899	... ...
Saigon-Bangkok	... Oct. 24, 1899	... ...

Telegraphists' Grievances.—The departmental commission appointed by the Duke of Norfolk to inquire into the complaint of the London telegraphists that a large percentage of the staff is compelled by the authorities to go on holidays in the winter months has, under the presidency of Mr. J. C. Lamb, drawn up a proposal to be submitted for the acceptance of the staff. The scheme, says the *Times*, which there is every reason to believe will be agreed to, secures for the general body holidays in the more favourable months, and in substance is as follows:—(*a*) Annual leave to be allocated in eight months of the year—namely, March to October. (*b*) All periods of annual leave as at present allotted to be curtailed by three days, such curtailment to be restored to each officer some time during the remaining four months. (*c*) *Pro rata* payment for duty performed on Bank holidays during the period of March to October to cease and leave in lieu thereof to be granted each officer, this to be added to the three days mentioned above.

The Telephone Service.—The Whitechapel District Board of Works will not grant an interview with the metropolitan superintendent of the National Telephone Company with reference to the Board's refusal to grant permission to the company to lay down telephone mains in certain streets of the district.

Wireless Telegraphy.—A Press despatch says that it has been decided to adopt the Marconi system in Cuba, and arrangements will shortly be made to establish communication between all the American West Indies by this means.

CONTRACTS OPEN AND CLOSED.

OPEN.

Birkenhead.—November 14th. The Corporation wants tenders for 13 single-deck and 31 double-deck electric motor cars, also for boilers, economisers, mechanical stokers, steam dynamos, booster and battery. See "Official Notices" October 20.h.

Birkenhead.—November 14th. The Corporation wants tenders for switchboard and instruments for the South End tramway generating station. See "Official Notices" this week.

Bradford.—November 9th. The Corporation is inviting tenders for 25 electric tramcar bodies, electrical equipments for same, and trucks and trolleys for ditto. See three of our "Official Notices" this week.

Croydon.—November 13th. The Guardians want tenders for electric wiring and fitting at the workhouse, infirmary, and union offices. See "Official Notices" to-day.

Essex.—November 27th. The Governors of Felsted School, Essex, are inviting tenders for boiler, two 27-kw. steam dynamos, condenser, pipework, accumulators, cables, and switchboard for electric lighting. See "Official Notices" this week.

France.—November 14th. Tenders are being invited by the French Post and Telegraph authorities in Paris for the supply of 10,000 metres of pipes 80 mm. diameter for pneumatic despatch tubes. Tenders to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

(*Continued on page* 683.)

ELECTRO-PNEUMATIC SIGNALLING.

In a recent issue we were able to place before our readers some interesting details with respect to the application of electricity to lighting, and various other purposes, at the new Boston Railway Station. Some idea of the magnitude of this building may, perhaps, be conveyed by the fact that it covers ground to no less an extent than 12 acres, while the total area pertaining to the station proper is 35 acres. The platform arrangements provide for luggage, baggage, &c., being dealt with on one platform, while that on the other side of the train is devoted to the passengers. Thus the officials are enabled to proceed with their work uninterrupted by the passengers, and the passengers, on their part, are able to select their seats without experiencing that inconvenience so characteristic of our large terminal and other stations consequent upon passengers and luggage being huddled together upon one and the same platform. Time and temper are saved; the dispatch of the train is effected more certainly and more smartly than is possible under the system which obtains with us. Greater space is necessarily occupied, for, at least, there must be one platform devoted to luggage to every two appropriated to the passengers; but where this space can be spared, there is reason to believe great convenience, with ultimate economy, will attend its adoption. Although, perhaps, not entirely novel, yet another feature of this station is the employment of subway lines, forming loops with the main lines, for the local service. These subways are lines having their own platforms and connections, by steps and slopes, with the platforms, &c., of the main station.

Fig. 1.—Signal Cabin and Power House.

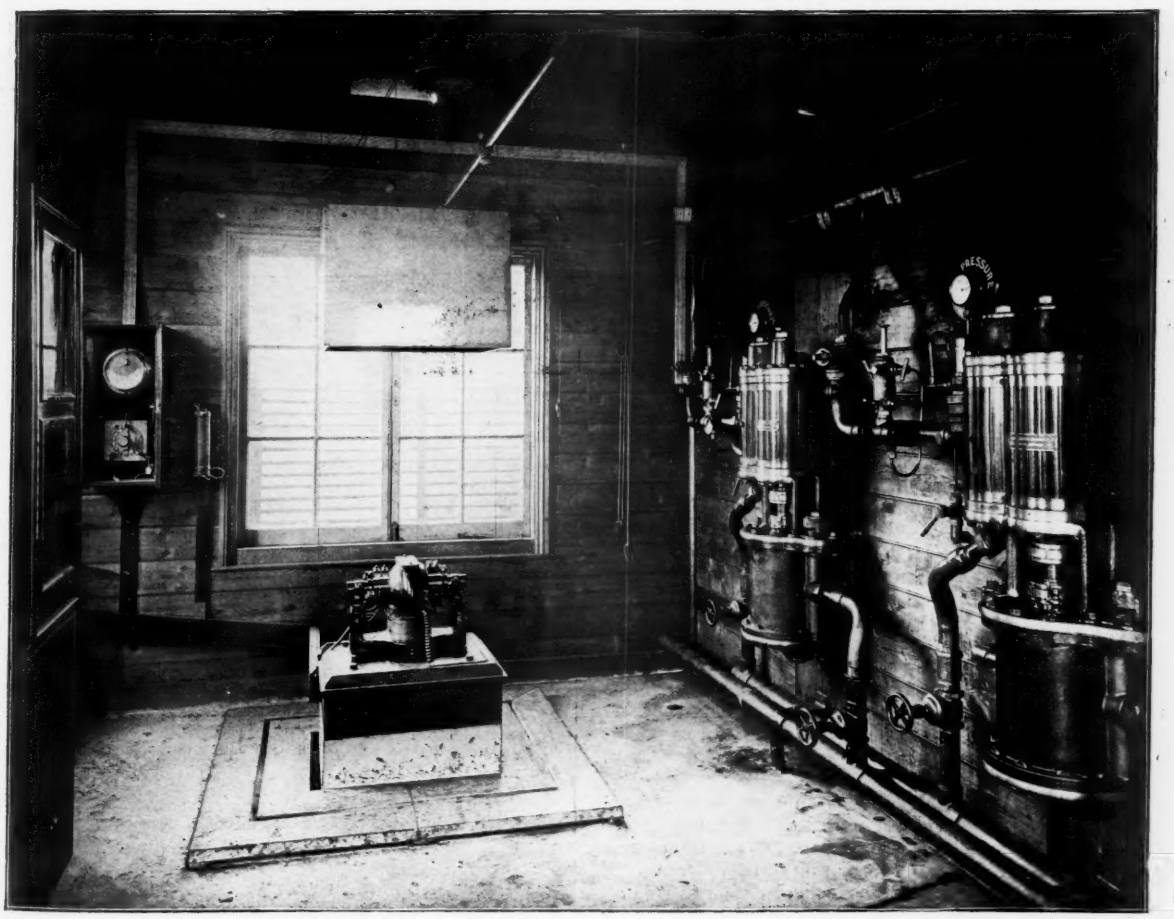


Fig. 2.—Interior of Power House, Spitalfields, G.E.R.

F

They are signalled and operated from the signal cabin that deals with the signalling of the upper or main lines. Whether

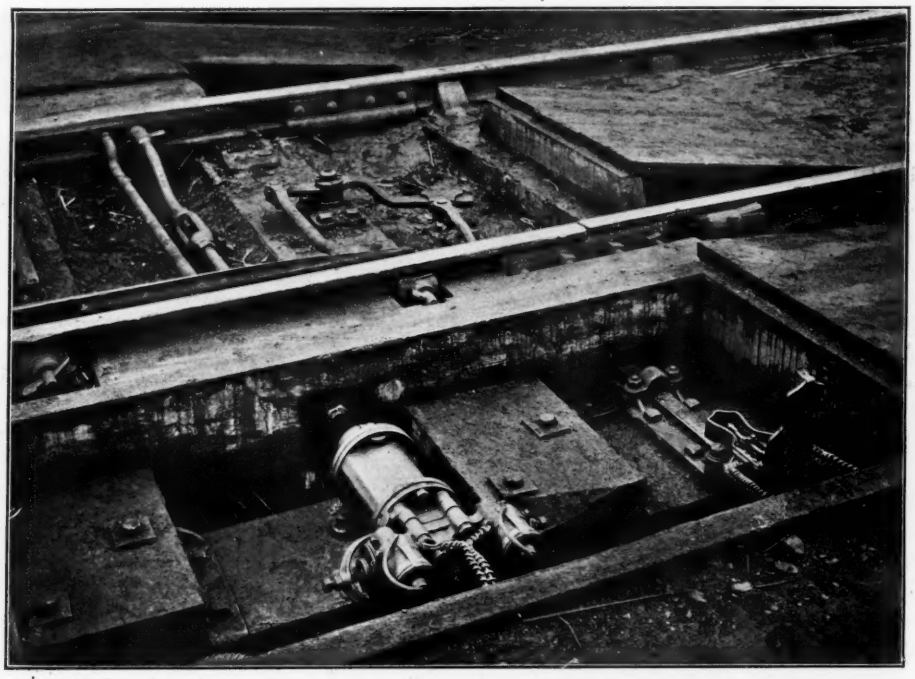


Fig. 3.—Trailing Point Lay-Out.

these subway roads will be worked by electrical power or compressed air has not so far been determined, but there can be little doubt that electricity will form the motive agency.

It is not, however, our forte to discuss the arrangements of the station so much as the mode and manner in which these arrangements are met by, or call for, the aid of electricity. We have already dealt, as fully as the space at our disposal would admit, with its application to lighting, and its use for motor work. It is gratifying to observe how universal has been its application to every purpose. Whether for passenger lifts, goods lifts, traversers, or other kindred purposes, electricity stands as the agent. We wonder how long it will be before our own railways grasp the fact that economy resides in the general application of this form of energy, not merely to lighting, but to all purposes in which power is called for at such points. Why should expensive hydraulic plants be laid down along with machinery for lighting, when the same agency which effects the lighting is quite capable of doing the work for which the hydraulic machinery is provided? Doubtless its advantages will some day be recognised on this, as they have already been on the other side of the Atlantic. In the meanwhile the equipment of the new Boston station may be accepted as an object lesson worth considering.

It is the mode of dealing with the operation of the signals and points to which we are desirous of devoting this article. The switching and signalling system includes a very complete installation of electro-pneumatic interlocking apparatus. Two interlocking machines are required, and these are located in two signal "towers," analogous to our signal boxes. In each of these towers, operating models of the tracks are provided, upon which each movement of the points, or switches, and signals may be duplicated in miniature, so that the operators may have before them the exact arrangement of the roads or signals under their control.

Both the points and the signals are operated by compressed air, controlled by electricity. The signals are arranged, in some cases, on the ground, but chiefly on wide signal bridges, varying in span from 50 to 120 feet.

The power plant is contained in a well-designed building 460 feet long and 40 feet wide. Here provision is made for the lighting, heating, refrigeration, and power required throughout the station. The total horse-power laid down is 2,000, and the building makes provision for an increase of 50 per cent. on this.

In the employment of compressed air controlled by electricity for operating the points and signals there is—in principle—nothing new; but it is doubtful if it has ever been employed, generated from one centre, over so large an area, or for so extensive a system. In England, although

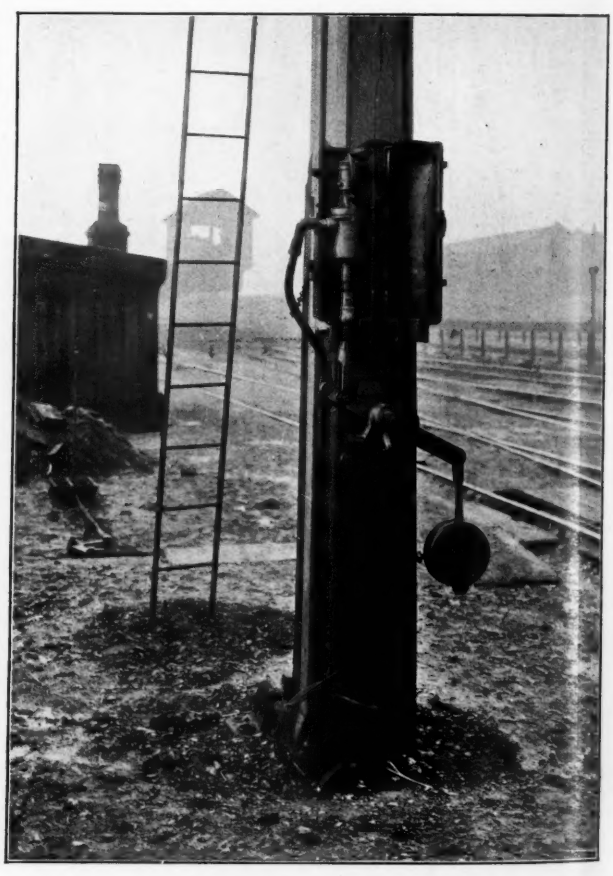
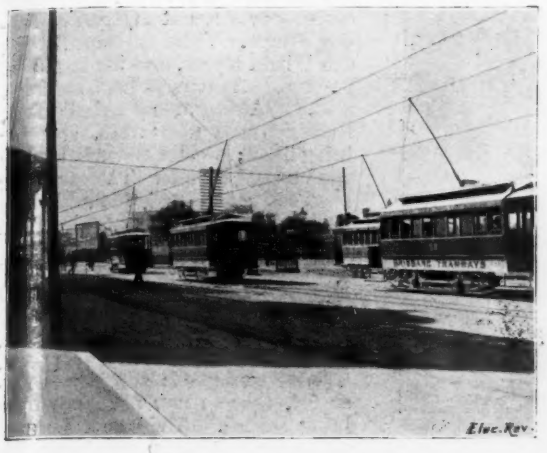


Fig. 4.—Signal Motor.

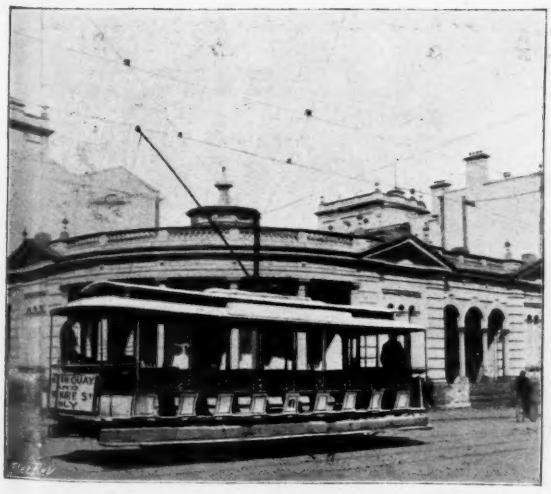
the subject has for some time been before the railway management, we have but one application of it—that at the

Bishopsgate Goods Yard, on the Great Eastern Railway. This goods yard, as may be imagined, is an extremely busy one, and it, no doubt, is an excellent selection as a test of the



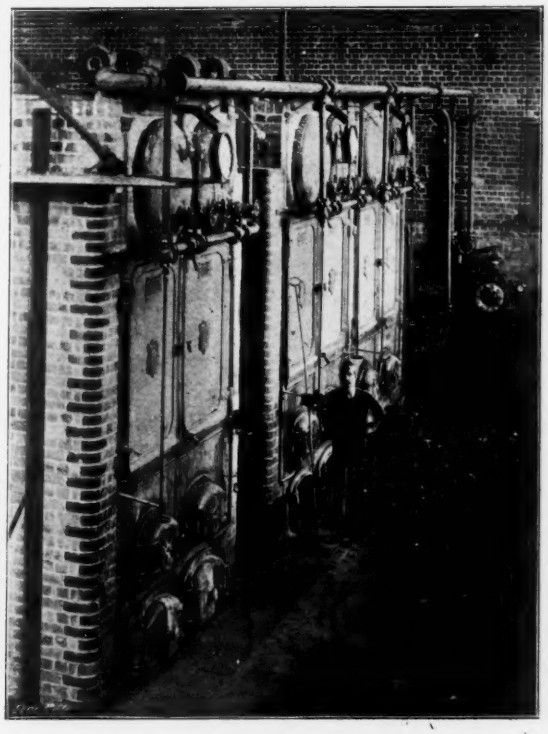
Brisbane Tramways.

Brisbane Tramways.



Brisbane Tramways.

suitability of such a method of working to English railway requirements. As such, some reference to the details involved may be of interest to our readers. In the United States the place from which the points and signals are operated is spoken of as the signalling tower. In England we use the expression signal box. The arrangement and design of the buildings is not by any means identical, but there is this, on that point, to be said—the signal boxes used on British railways are the outcome of experience of our needs. No doubt the same may be said of the system in operation in America. The requirements differ; traditions differ; the conditions, taken as a whole, are totally distinct. In England our commercial centres and towns are within easy reach of one another. Manufactories abound; even along the lines of railway we find siding connections affording access to factories, works, &c. All these need signal protection, the operation of points, &c., and naturally they become signalling centres. In America, outside the large

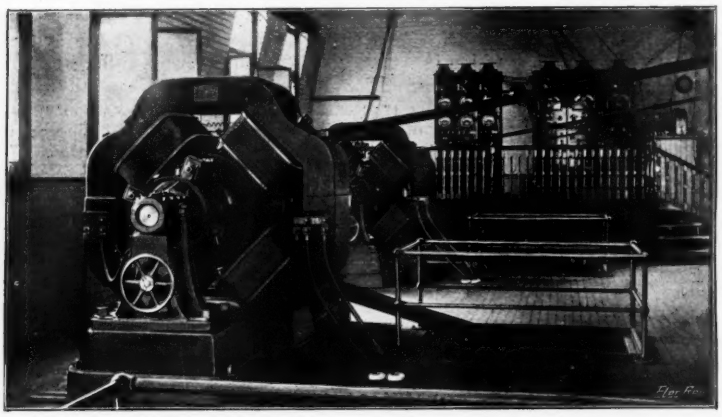


Brisbane Tramways.—Boilers.

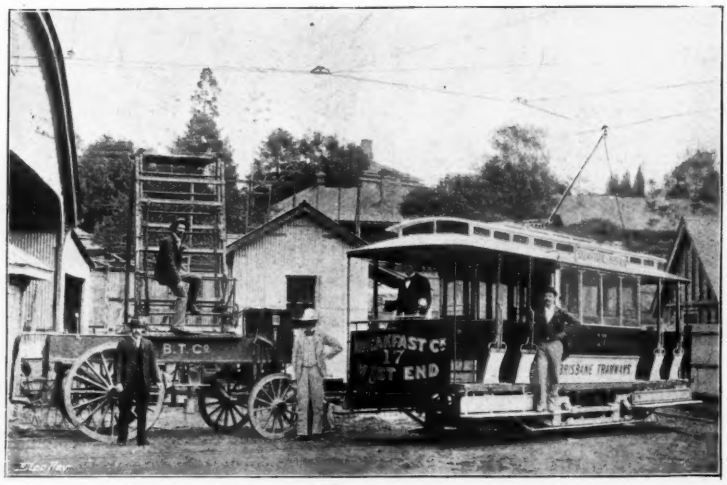
commercial centres, long stretches of country intervene. Under these circumstances automatic signalling has been a necessity, and hence the extent to which this form of signalling has been adopted, and the preference for it, which obtains in the United States, and which marks such a wide difference in the general mode of signalling trains in America as compared with the practice pursued in this country.

Fig. 1 is an illustration of the signal box containing the necessary switching and signalling apparatus for operating the Bishopsgate yard. Adjoining it is seen the power house, air reservoirs, &c. Fig. 2 shows the interior of the power room. The air pumps are in duplicate, and, in this instance, are operated by hydraulic power—that form of power being available for the purpose, it was felt unnecessary to establish independent generating plant. Each pump has an automatic governor, seen to the left of the illustration, which stops the water supply as soon as the air pressure reaches 75 lbs. per square inch. Leaving the pumps the air is passed through the group of bare iron pipes, seen in fig. 1, adjoining the power house, and which form a condenser, and serve to dissipate the heat generated by the compression of the air, and also to condense the moisture. The air is now carried to the reservoirs, if reservoirs are used. It will, however, be evident that these are not in all cases necessary, and that under any circumstances their capacity may be of a very limited character. The amount of air required per minute in this plant is about 10 cubic feet, measured at atmospheric pressure. Where reservoirs were used the consumption would,

of course, control the size of the reservoirs. From the reservoirs the air is distributed by means of a 2-inch main, with branch pipes of ¾-inch diameter, as required. Auxiliary reservoirs may be used as found necessary; where the system entails a considerable extent of piping, they are desirable, and, under any circumstances, are of advantage in inducing a more prompt action of the parts they control. These branch pipes, as will be understood, terminate at the cylinders and apparatus operating the signal or point connection.



Brisbane Tramways.—Generators.



Brisbane Tramways.—Repairing Tower.

Fig. 3 shows the parts controlling a point connection. To the left of the engraving is the air cylinder; to the right of it is the locking piece, with its lid raised.

Fig. 4 is from a photograph of one of the signals, showing the gear applicable to it. The cover of the cylinder valves and electrical parts is thrown back so as to expose the internal arrangements. The position of the signal arm is that indicating danger. To place it in the "all-clear" position, air has to be compressed into the cylinder, and that end of the lever, to the opposite end of which the weight is attached, has to be pressed down so as to elevate the weight end of the lever to an angle of some 30° from the position shown in the illustration.

(To be continued.)

BRISBANE ELECTRIC TRAMWAYS.

Our Sydney correspondent sends us some photographs of the electric trolley system at Brisbane, Queensland, along with certain particulars of the power house and line equipment.

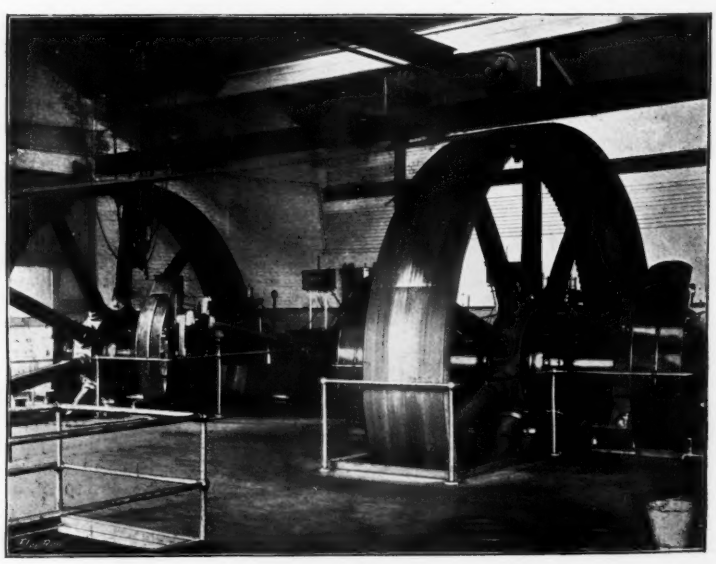
The tramways are in the hands of a company, and they are doing very well. As happens in all towns or districts where electric traction is introduced, the service is unquestionably a great boon to the public. The system covers altogether some 18 miles of streets, or about 30 miles of track. The overhead work is almost entirely span wire construction, with iron tubular poles.

The power house is situated fairly centrally near the Roma Street Railway Station. There are three Babcock and Wilcox boilers, working at 150 lbs. pressure. At present, hand stoking is used, but American mechanical stokers, feeding from underneath, are now being fitted; a water tower is used for condensing purposes. The generating plant consists of three General Electric multipolar generators, belt-driven from Robey horizontal compound engines.

The switchboard is also of General Electric manufacture, with the usual panel arrangements. There are three feeder panels, each carrying two feeders, but only two panels are in use at present. The remaining one will soon be occupied, as two new feeders are now being erected. The standard size of the feeders is 500,000 circular mils.

The feeders are all run overhead, as, curiously enough, though the Brisbane Electric Supply Company are compelled to run their mains underground, it has been ruled that the Tramway Company may not do so.

There are in all some five different types of car running, the majority being of a composite type, with the centre portion enclosed, and at each end a section with open ends and sides, as shown in the adjoining figure. Most of the cars of the enclosed type are made up of two of the old horse-car bodies joined together. All cars were built by the company; the trucks, which are of the Peckham type, being imported. A special car has been built for pleasure parties, the intention being to run it over the various lines, going by



Brisbane Tramways.—Engines.

one route, and returning by another, with a fixed charge for the whole trip, or letting it out to private parties for the same purpose. The car is quite open, as shown in the photo, but arrangements are being made for a removable awning; the seats are made removable, so that in the event of private parties taking it, chairs can be substituted. It is anticipated that there will be a great demand for this car on hot summer nights.

Our correspondent also informs us that there is a big scheme on foot for purchasing the whole of the Adelaide tramway system, and converting the present horse lines into an electric system. The Westinghouse Company and their Sydney agents, Messrs. Noyes Bros., are the parties principally concerned in the deal, and negotiations are so far advanced as to only require the necessary Parliamentary sanction to be complete. There are seven tramway companies to settle with, and it is said that the purchase price is somewhere in the vicinity of £800,000.

CONTRACTS OPEN AND CLOSED.

OPEN.

(*Continued from page 678.*)

Glasgow.—November 14th. The Corporation wants tenders for two 800-H.P. compound vertical auxiliary engines for the new tramway power station at Port Dundas. See "Official Notices" October 13th.

Glasgow.—November 20th. The Electricity Department want offers for 10 miles of 2-inch cast-iron pipes. See "Official Notices" October 13th.

Hoylake and West Kirby.—November 15th. The Council is wanting tenders for Lancashire boilers, superheaters, economiser, steam engines, alternators, motor alternator, crane, wiring, steam, &c., piping, switchboards (high and low tension), batteries, transformers, concentric mains, &c., &c. See "Official Notices" October 13th.

Llandudno.—November 6th. The Council wants tenders for three 150-KW. high speed engines and dynamos, also motors and boosters. See "Official Notices" October 20th.

Maidstone.—November 6th. The Corporation wants tenders for steam dynamos, balancers, boosters, boilers, economiser, surface condenser and feed pumps, switchboard, &c., battery, crane, mains, arc lamps and posts, and electricity meters. See "Official Notices" October 20th.

Middlesbrough.—November 22nd. The Electric Lighting Committee wants tenders for condensing plant and pipe-work for the electricity works. See "Official Notices" October 20th.

Morecambe.—The Urban District Council wants tenders for boiler, steam dynamos, switchboard, transformers, mains, pumps and condensers, and storage batteries for electric lighting extensions. See "Official Notices" October 13th.

Newcastle-on-Tyne.—November 30th. The Tramways Committee wants tenders for two 1,000-H.P. steam dynamos for electric tramway works. See "Official Notices" this week.

Port Alegre.—December 31st. The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Minister at Rio, stating that tenders are invited by the municipality of Porto Alegre, not later than December 31st next, at 1 p.m., for the electric lighting of that town.

St. Pancras.—The Vestry wants offers for the supply of temporary generating plant for the Regent's Park electricity works. See "Official Notices" October 20th.

Spain.—November 7th. The Spanish Ministry of Public Works in Madrid is inviting tenders, until November 7th, for the concession for the construction and operation of an electric tramway in the town of Cadiz. Particulars may be obtained from, and tenders are to be sent to, La Direccion General des Obras Ribleas, Madrid.

Sydney (N.S.W.).—November 3rd. The Municipal Council of Sydney is inviting tenders for the construction and erection of a refuse destructor for treating 60 tons of refuse per day (24 hours).

Warsaw.—The Secretary of State for Foreign Affairs has received a despatch from Her Majesty's Consul-General at Warsaw, stating that tenders are invited by the municipality of that city for the construction of freezing chambers and electric lighting in the covered market halls. The latest date by which the tenders have to be sent in has not yet been fixed. Such particulars as have been received may be examined at the Commercial Department of the Foreign Office between 11 a.m. and 5 p.m.

Wrexham.—November 8th. The Council wants tenders for boiler house plant, engine house plant, dynamos, switchboard, mains, posts, battery, meters, crane, and buildings for electricity works. See "Official Notices" October 13th.

CLOSED.

Colwyn Bay.—The District Council has given the contract for electricity works' buildings to Mr. Thomas Brown, of Chester, at £1,910.

Glasgow.—Messrs. M'Callum & Hope are to supply the iron stairs required for the Port Dundas electric power station at a cost of £142 3s. 8d.; Messrs. Mechan & Son the switchboard galleries for £600; and Messrs. Hayward Brothers & Eckstein, Limited, the floor lights for these galleries for £610 16s. 8d. Messrs. Babcock and Wilcox, Limited, are to provide and erect at the Pollokshaws Road station four water-tube boilers, with galleries and ladders, similar to the five boilers they are now erecting at Port Dundas station, and at the same price for each boiler. The amount of the contract is £5,446. Messrs. D. Stewart & Co., Limited, are to provide and erect for £998 10s. two wagon hoists, with mild steel chains, at Pollokshaws Road station. The contract given to the Clayton Engineering and Electrical Construction Company, Limited, of Clayton, Manchester, to which reference was made last week, is for two 50-ton electric cranes (£4,260) and one 30-ton (£1,350), with a 76-foot span. These are for the Corporation electric tramway station at Port Dundas.

Poplar.—After considering Mr. Warden Stevens's report on the tenders received for Sections F, G, and J of the scheme of engineering works at the workhouse, contracts have been placed as follows:—Section F, high speed (enclosed) engine and dynamo, Thames Ironworks Company, Limited, £827; Section G, electric motor, Fuller-Wenstrom Electrical Company, £419; Section J, economiser, James Carter & Sons, £99 10s.

FORTHCOMING EVENTS.

Friday, October 27th.—At 5 p.m. Physical Society meeting at the rooms of the Chemical Society, Burlington House. Agenda:—"The Magnetic Properties of the Alloys of Iron and Aluminium," by Dr. S. W. Richardson. Exhibition of a model illustrating a number of the actions in the flow of an electric current, by Mr. G. L. Addenbrooke. Repetition of some experiments with the Wehnelt interrupter devised by Prof. Lecher, by Mr. W. Watson.

At 8 p.m.—Institution of Mechanical Engineers. General Meeting, Sir W. H. White presiding.

At 8 p.m.—Electro-Harmonic Society's Smoking Concert at International Hall, Café Monico, Regent Street, W.

Saturday, October 28th.—Manchester Association of Engineers. Mr J. S. Raworth on "Generation and Electrical Distribution of Motive Power."

Thursday, November 2nd.—At 8 p.m. The Civil and Mechanical Engineers' Society opens its 1899—1900 Session at Hôtel Victoria, Northumberland Avenue, S.W. Paper:—"A Short Account of Some Modern Steam Wagons," by Mr. G. A. Burls, Wh. Ex., A.M.I.C.E.

Friday, November 3rd.—At 8 p.m. The Institution of Junior Engineers, at the Westminster Palace Hotel. Presidential address by the Hon. Charles A. Parsons, F.R.S.

Tuesday, November 7th.—At 8 p.m. Institution of Civil Engineers. Address by Sir Douglas Fox, president, and presentation of medals and prizes awarded by the Council. Reception by the President in the library after the meeting.

Tuesday, November 14th.—Institution of Civil Engineers. "The Waterloo and City Railway," by H. H. Dalrymple-Hay, M.Inst.C.E.; "The Electrical Equipment of the Waterloo and City Railway," by B. M. Jenkin, Assoc.M.Inst.C.E.

Thursday, November 16th.—At 8 p.m. Institution of Electrical Engineers' opening meeting. Presentation of premiums and inaugural address, by President S. P. Thompson, F.R.S.

NOTES.

London's Lost Tunnel.—As we go to press Prof. Chas. A. Carus-Wilson writes: "In your criticisms of my letter of the 16th inst., you ridicule Mr. Barlow for taking the speed of the engine as an indication of the rate of working, for the speed, you say, would be kept constant by the governor, and therefore independent of the load. Your remarks would have some weight if, in Mr. Barlow's experiments, the speed had been controlled by a governor, but this was not the case. The admission of steam was regulated by a throttle valve worked by hand, so that the speed of the fan was liable to vary with changes in the load. Mr. Barlow's results are thus not so transparently silly as you would make them appear."

Volta and Como. — Although this journal is not primarily devoted to the study of ancient history, we need not apologise for the somewhat lengthy extracts we are printing from Prof. Righi's published address on the scientific work of Volta, delivered at the Volta Centenary at Como. Some of these extracts have been selected for their historical, some for their scientific, interest: the Italian originals of others are superb specimens of rhetoric. The work of Volta and his contemporaries is an inspiring subject. It was so sound, and has proved so fruitful. They laid securely the foundations of electrostatics and of electrolytics with no better means of detecting electrical action than the condenser and electroscope, or that "stupendous discovery," the frog's leg. The modern influence machine, and quadrant electrometer, and the mathematical methods of Fourier, Green, and Thomson are greatly in advance of anything known to them, but none of their work has had to be undone. The death of Volta nearly coincided with the discovery of electro-magnetics, the most momentous of all discoveries, and the period of his life may conveniently be taken as the embryonic period of our science.

American Competition.—We are free to admit much that is said of American competition, but at the same time we have not much faith in its reality. It is less American competition than English apathy that makes it appear as though competition were serious. We have had many a fling at the follies of the trades unions, but we might equally well condemn the methods of our manufacturers, who have been so singularly remiss in setting themselves out to meet the demand. Our electrical companies ought to-day to be full of traction work. We could name half-a-dozen engineering works that should be busy on traction work in place of standing aloof, or supplying goods in a perfunctory and half-hearted manner. Col. E. A. Stevens is writing a series in *Engineering* on American competition, which goes over again the old arguments and glorification of the American workman as a divine kind of creature. But we cannot altogether agree that the American manufacturer is so receptive, or inclined to suit customers. Only recently we met with an example of the intense conservatism of the American manufacturer, who declined even to quote for an addition to the article he made—an addition badly needed, and one which implied no alteration to patterns. He simply wrote a wordy letter of excuse and false argument, and this is but one of many instances we have met of the same ultra-conservative spirit, and an inability to accept suggestions from users. We have elsewhere referred to this subject in respect of the American lathe, which, good up to a point, is absolutely devoid of any satisfactory means of using it, having no strong tool-holder. So prejudiced and blind are the makers of American lathes that they will not even bear criticism from their own Prof. Sweet, who has been roundly abused for attacking this very point of weakness. American competition—such as it is—is on the American side very much (we had almost written entirely) a question of shop methods. But it is not the formidable thing that half-asleep people on this side try to make it out, and would be as nothing if capital and labour here could only arrive at an amicable understanding. We believe that English manufacturers are too much inclined to ask longer time for carrying through an order than is necessary for them, and they are not pushing business as they should do. They simply allow thousands of pounds to slip through their fingers because they will not take the trouble to ascertain prices and ask for orders.

Accumulator Traction at Paris.—The Compagnie Générale des Omnibus is making preparations to substitute on its lines vehicles deriving their propelling power from storage batteries. The *Electrical World* says that there will be a central station at Montreuil of 2,000-KW. capacity, though, for the present, only 1,600 KW. will be installed. There will be two charging stations, both situated in Vincennes. The generators will be driven by de Laval steam turbines. Tudor storage batteries will be used in one charging station and Blot batteries in the other.

Loss of the Cable Ship "International."—Having noticed the loss of a vessel of this name, we made inquiries at the offices of the Silvertown Company, and found that, as we had surmised, it was the cable steamer *International* that had found a last resting place in the Birling Gap, under Beachy Head, and on the westward side. We learned that the vessel went ashore during the late heavy gales while being towed from London to Cherbourg to be broken up, and that by some strange fatality she drifted athwart a submarine cable laid from her some 26 years ago. The *International* was one of the first steamers, if not the first, which left the ways of the shipbuilding yard with cable tanks and other cable fittings on board, and was christened the *International* on account of the nature of the work she was destined to carry out. All other vessels employed in the cable service before the *International's* launching, had been converted into mail or cargo steamers. During her 30 years of cable service the *International* has transported and laid many miles of cable in the Mediterranean, in the Persian Gulf, in the North and South Atlantic, and in the Pacific Ocean. She had on several occasions been chartered by the Postmaster-General before the Government Telegraph Department had a telegraph ship of its own, and was also employed by Government as water-condensing transport at Suakin during the Egyptian campaign. The vessel began her career in troublous times, as shortly after laying a cable between Great Britain and the Channel Islands, she was called upon to lay some short cables for the French Government in December, 1870, and her employment in this work gave rise to a lawsuit, under the Foreign Enlistment Act, in which the India-Rubber, Gutta-Percha, and Telegraph Company made a successful defence against Her Majesty's Government. The work undertaken was the laying of a series of cables (1) between Gravelines, in the Pas de Calais Department, and Cherbourg; (2) between Flamanville and St. Brieuc, in Brittany; (3) between Quiberon and Belle Isle, on the Atlantic seaboard of France; and (4) between Belle Isle and Verdun, near Bordeaux. Besides the ordinary dangers of the sea during winter, there existed others which necessitated an escort, and the ironclad *Thétis* and the composite paddle frigate *Ctesiphon*, of the French Navy, accompanied the *International* and her consort, the French Government cable vessel, the *Ampère*. In spite of many troubles, including running ashore in a heavy fog, the *International* successfully completed her work in a very short period of time, and Faidherbe's Army of the North at last found itself in telegraphic communication with Orleans and Bordeaux. The work done by the *International* was that which every cable ship is called upon to perform, and whereas when she was launched vessels in her class of employment numbered nine, there are now about 40, whose sole occupation is the laying and maintaining of telegraph cables. The *International* was a good staunch vessel, and has left behind her a record of excellent work.

Suggested Improvement in Overhead Trolley Construction.—The *Engineer* mentions that in a German electrical journal there recently appeared a description of a magnetic arrangement for doing away with the springs in the trolley pole bases used for overhead electric traction. When the height of the overhead conductor varies, there is a tendency on the part of the trolley to leave the conductor, with the result that the pole strikes and breaks the span-wires before the car comes to rest. In order to avoid this risk, the author proposes to dispense entirely with springs in the trolley base, and to substitute for them a coil-and-plunger mechanism traversed by the main current. If the trolley should be thrown off the conductor, the excitation of the magnet ceases, and the trolley pole falls down out of harm's way.

Electric Canal Traction.—Our New York namesake says that the Erie Canal Electric Traction Company was organised recently to introduce electricity as a motive power, not only upon the Erie Canal, but upon all the canals in the United States, and upon the canals of France and Holland. It possesses patents applying electricity to a motor or tractor which, from the tow-path, so it is said, will propel or tow six ordinary canal boats of 240 tons each five miles an hour. The capital of the company, amounting to $5,000,000, has been underwritten by a Wall Street syndicate.

Cowper-Coles Sound Locator and Projector.—This instrument, which we illustrate, is for the purpose of readily locating the direction of a sound, and for projecting sound long distances. The instrument consists of a reflector, which is made entirely by electro-deposition, mounted on an arm which can be readily turned on its centre, and depressed or elevated by the operator. When it is desired to ascertain the exact direction from which a sound emanates, the apparatus is turned on its axis, and as soon as the reflector is opposite the source of sound it is heard much intensified in the receiver. When it is desired to carry on a conversation

between two distant ships or points, two instruments are used, so that the beam of sound is thrown from one reflector to the other, and focussed in the receiver of one instrument. One operator speaks into the flexible tube, while the operator working the other instrument places the tube attached to the receiver to his ear. Conversation can thus be carried on at long distances without unduly raising the voice. Some experiments have recently been made at St. Margaret's Bay, near Dover, with this instrument. The ticking of a watch, when placed in the focus, could be distinctly heard about 20 feet away, even with a strong breeze blowing across the direction of sound.

Incandescent Lamps of Small Candle-power.—A New York contemporary says that the French Société d'Encouragement des Industries Nationale some months ago offered a prize for the best lamp of 2 C.P., the voltage to be 100. One of the conditions of the test was that the lamp should have a life of at least 400 hours. Lamps were offered by three manufacturers in competition for the prize, but the committee appointed to undertake the tests did not make an award for the reason that only one lamp had a life outside the minimum period. Each of the competitors, however, was given a silver medal in view of the excellence of the lamp presented in other respects than life. New propositions have been made in which the life is fixed at a minimum of 500 hours as a mean of five lamps tested. The prize will be awarded in 1901.

General Post Office.—Mr. M. Cooper has been appointed Principal Technical Officer of the Postal Telegraph Department.

The Universal Exhibition of 1900.—We have received the following circular letter from the French Ministry of Commerce:—

INTERNATIONAL CONGRESS OF ELECTRICITY

(Paris, August 18th—25th, 1900).

Sir,—The Universal Exhibition of 1900, which will assemble at Paris a number of scientists and engineers from all parts of the world will offer an exceptionally favourable opportunity for the study of those questions of general interest which are now no longer confined within the limits of a single nation, but extend over the whole area of civilisation. French electricians have thought that it would be to the general advantage, under the circumstances, to form and organise in 1900 an International Congress of Electricity. Since the Paris Electrical Exhibition of 1881, congresses of this kind, held in different countries, have marked the progress of electrical science and industry.

Questions of units and terminology formed, at first, the subject of discussion at these conferences, and we appreciate daily the immense benefits of the resolutions passed with international approval. During the last 20 years, a period very short in itself, but one which will hold a glorious place in history, we have witnessed the most unforeseen discoveries, fresh applications of researches that had seemed to be confined to the domain of pure science, and an extraordinary extension of electrical industries. Practice has brought into evidence a number of problems, concerning which it will be both interesting and profitable to gain the views of technical men. It seems, therefore, that, without detracting from the importance rightly attached to questions of theory, the discussions of the Congress will be mainly of an industrial and economic nature. In view of this probability, the accompanying programme indicates provisionally the manner in which the work will be distributed among the various sections of Congress.

The report of the meetings, with the papers accepted by the Committee will appear in a publication distributed gratuitously amongst the members.

We hope that you will give us your valued assistance by associating yourself with the work of the Congress of Electricity of 1900. We send you herewith a form of application, which will merely have to be filled up and returned to the address indicated.

E. MASCART,
President of the Committee of Organisation of the Congress of Electricity.

Vice-Presidents. E. MOISSAN, H. FONTAINE, C. M. GABRIEL.

Secretaries. E. JANET, E. SARTIAUX

Programme.

I.—Scientific Methods and Instruments of Measurement.
II.—Generation of Electrical Energy—Transformers—Transmission and Distribution—Electric Lighting—Electric Traction.
III.—Electro-Chemistry—Electro-Metallurgy—Accumulators—Electric Furnaces.
IV.—Telegraphy—Telephony and various Applications.
V.—Electro-Physiology.

The very comprehensive nature of the programme gives ample scope for the choice of a subject on which to read a paper, and having in view the importance which this Congress is likely to acquire, we anticipate a very high standard in the quality of the proceedings. The most popular and interesting sections will probably be Nos. II. and III.; but so rapid has been the progress made in all departments during the last few years, that there can be no lack of valuable communications in any section.

The Transvaal War.—Among those who have left for the front is Major W. C. Beevor, of the Royal Army Medical Corps, who takes with him a complete *X* ray equipment, with which he will be able to render great service to his country and to those fine brave fellows who are now fighting for us, by minimising their sufferings in bullet localisation and extraction. Major Beevor's practical experience with the apparatus in Indian warfare renders him eminently suited for the present service. He takes with him a Pidgeon influence machine, in which he is understood to have made certain alterations to enhance its fitness for the particular conditions under which it will be employed.

A daily paper says that the War Office has contracted with the Wireless Telegraph and Signal Company for the use of the Marconi system in South Africa for a period of six months. Captain Kennedy, R.E., superintendent of railway telegraphs, Natal, is stated to have left Southampton for Durban, taking the six sets of apparatus and a staff of assistants and operators. It is stated that the first installation will be for communication between Durban and the bar off the port. It is outside this bar that the troops from England are disembarked into tenders for landing. By wireless telegraphy these operations may be facilitated.

The Manchester Society of Junior Electrical Engineers.—A visit was paid on Saturday last to the Longsight printing works of the "Co-op." Wholesale Society by the members of the above society. These works are lighted throughout by electricity, the manager, Mr. G. Brearley, having induced the directors to provide electrical plant for both lighting and power. A description of the installation, prepared by Mr. A. Blackburn, the electrical engineer, and printed at the works, was presented to each visitor. The special points of interest relate to the motors, Lundell enclosed type, from ¾ to 7 B.H.P. and geared with rawhide pinions to cast-iron cogwheels. At the conclusion of the visit the president, Mr. W. Haldane Gee, moved a vote of thanks to the directors. He said that they were all convinced from the visit that electric driving was the best method for a printing works. In seconding the motion, Mr. Payne eulogised the excellent arrangements adopted in the boiler and engine house. Mr. H. Rust is hon. sec. of the society, and his address is 13, Harcourt Street, Gorse Hill, Stretford.

Charges for Electricity in Whitechapel.—A neat little booklet has been issued by the Board of Works, Whitechapel, over the signature of Mr. Arthur Wright, consulting engineer and manager, giving information for the benefit of prospective consumers as to the conditions under which they may obtain supply of electricity. The charges are based on a novel system, and are lower than those of any similar undertaking in this country, not excepting stations which have been running for some years. During the six summer months ending at Michaelmas a uniform rate of 1d. per unit is charged; during the winter the consumer may pay 1d. per unit + a monthly rental of 1s. per 8-C.P. lamp used, or, at his option, 1d. per unit after the lamps have been used 60 hours per month, the electricity consumed during these 60 hours being charged for at 8d. per unit. The charges will be made out on the maximum number of lamps simultaneously used during the month, as shown by the demand indicator. A table is added showing the probable cost of electricity used for various purposes and periods, as compared with the cost of gas, very greatly to the disadvantage of the latter!—and it is stated that lamps used from dusk to 11 p.m. throughout the year will cost on the average 2½d. per unit, while lamps used in dark places 12 hours per day will be supplied at 1½d. per unit, the saving in the latter case being sufficient to pay the entire cost of the installation in 18 months. The new line taken by Mr. Wright evidently affords strong encouragement to a demand in the summer months. Moreover, as the maximum demand is ascertained for each month instead of each quarter, the consumer will benefit from this cause also. We must congratulate both the Board of Works and Mr. Wright for their courage and enterprise in adopting such a low tariff from the commencement, and we shall watch the future progress of the undertaking with great interest.

Lecture.—Prof. Oliver Lodge lectured at the University College (Physics class room), Liverpool, on 18th inst., on "The Scientific Principles of the Electric Telegraph." The lecture was the first of a series. A short historical sketch of the subject was concluded with an account of the new light thrown on the science by the discoveries of Prof. J. J. Thomson, of Cambridge, which went far to revolutionise all our theories of matter, and which were enunciated last month at the meeting of the British Association at Dover. The lecture was illustrated throughout by experiments and lantern slides.

Personal.—On Friday evening at the Tower Grounds, New Brighton, Mr. Bartlett, electrical engineer of the Tower, was the recipient of a very handsome marble clock and ornaments to match, as a token of esteem by the officials and staff of the New Brighton Tower.

We learn that Mr. Wilfrid L. Spence, A.M.I.C.E., M.I.M.E., of the Electric Construction Company, has been appointed managing director of a new company which is being formed in Scotland with the object, *inter alia*, of undertaking the bulk supply of electricity to local authorities. Mr. Spence's headquarters will be in Glasgow.

The Babcock & Wilcox Superheater.—Superheating does not make very rapid progress, but it ought to do if the *American Electrician* is to be believed. In describing the Babcock & Wilcox superheater, an attempt is made to give the reasons for the economy of superheating, in doing which a very serious mistake is made. Steam at 100 lbs. pressure has a temperature of about 337°. If exhausted at 212° the working range will be 125°, and on this depends the work to be got from the steam. If, however, says the *American Electrician*, the steam be superheated to 462° or by 125° additional temperature, the range down to exhaust will now be 250°, or double what it was without superheat, and "the steam consumption per horse-power-hour will be theoretically only half as great. The true theoretical formula for the heat utilisation is $\frac{T_1 - T_2}{T_1}$ when T_1 is the absolute temperature of the initial steam and T_2 is the final pressure. Applying the formula to the two conditions cited, we have first—

$$\frac{(337 + 459) - (212 + 459)}{337 + 459} = \frac{125}{796} = 0{\cdot}157,$$

and in the second case we have

$$\frac{(337 + 125 + 459) - (212 + 459)}{462 + 459} = 0{\cdot}271.$$

The theoretical improvement is 72 per cent. not 100 per cent. Even the 72 per cent. will not, we need hardly say, be realised, nor, indeed, is there much to be expected in practice from the theoretical side. The real practical improvement in economy comes in quite outside any mere theory, for it is connected with the vexed question of the action and reaction of the cylinder metal upon the steam. Another errror in the same article lies in the assumption that the initial boiler steam in torpedo boats is throttled down to the engines, for the purpose of superheating the steam so throttled. The idea is that as the boilers can stand the pressure, they may as well do so, the steam being throttled to the engines for mechanical reasons, and the superheat generated thereby is, so far as it goes, of value. It may not be generally known that an insufficient engine and boiler at low pressure may be improved by raising the boiler pressure and throttling down to the engine, if the former is strong enough, and the latter is too weak to carry more stress. A case once came under our notice of a boiler worked at 60 lbs., and throttled down to the engine, until the "folly" of thus "overstraining" the boiler was pointed out to the owner, who reduced the boiler pressure down to what the engine would carry. The result was that he could not run the place, for the engine used so much more steam. This proved the benefit of even the small superheat. In the Babcock superheater the superheater pipes are placed in the triangular space above the water tubes, and below the steam drum, and can thus receive fairly high temperature effects. Provision is made to fill the pipes with water during such time as steam is not flowing through them, thus preventing overheating. It appears that this superheater is being introduced in America from this side.

Electricity v. Gas.—An animated correspondence has been going on for the last fortnight in the *Pall Mall Gazette*, founded on the publication of some figures showing the comparative cost of the rival illuminants in the Whitechapel district, to which we refer elsewhere. Mr. L. De Fonblanque, general manager of the Incandescent Gas Light Company, took exception of the comparison as being misleading, and substitutes his own misleading figures. Mr. De Fonblanque claims "an efficiency of 25 candles per cubic foot of gas consumed" for the new Welsbach burner, leaving the time in which the cubic foot is to be consumed, to be guessed—we believe half an hour would not be far from the truth. The "new" Welsbach burner is a very different thing from the "old" one. It is well known that a burner which gives 50 C.P. to begin with, will fall to 30 C.P. in 500 hours at the outside. Neglecting this fact, however, Mr. De Fonblanque makes the cost of lighting by Welsbach burners one-seventh of that of electric lighting, when the average price of the unit is taken to be 2¾d., and regarding renewals as practically equal in both cases. If we take the average efficiency of the Welsbach at 13 candles per cubic

foot per hour, which is about correct, the ratio becomes nearly ⅓. But this is for the naked light, whose greenish-yellow glare is insupportable; when the mantle is surrounded with a suitable tinted shade the loss of light is so great that the ratio falls to equality. The opinions expressed by the various correspondents are of all shades. Mr. Fonblanque, when tackled on the score of decrease of candle-power with time, attempts a *tu quoque*—but does not explain why he suppressed the facts in his earlier letter. As a fact, however, although electric glow lamps vary in candle-power with time—not always decreasing—the average efficiency is about 4 watts per candle for the *whole life* of the lamp, so that the variation was implicitly allowed for in the first instance. After all, however, all this is beside the question. Mr. Wright's circular is addressed to the ordinary consumers, the vast majority of whom use bat's-wing burners, and these, beyond dispute, never give more than 2 C.P. per cubic foot per hour, and cannot compete on the score of cheapness, steadiness, healthiness, or any other feature with electricity.

The Heating of Enclosed Motors.—The occasional use of street railway motors for stationary work in exposed locations has proved so satisfactory, that a demand has arisen for enclosed motors which has compelled practically all manufacturers to place on the market a line of such machines. As the *American Electrician* remarks in an editorial, this demand exists in spite of the fact that such a machine costs considerably more than an open motor of the same power. This is due to the fact that the enclosed motor gets no ventilation, and therefore cannot dissipate readily the heat generated on heavy loads, and must be rated at a very low load. The result is that a motor which will, when open, safely carry 15 H.P. will, if enclosed, reach the temperature limit with a load of about 10 H.P., and its rating when enclosed must be correspondingly reduced. Our contemporary adds that the only way in which the heat is dissipated from an enclosed motor is by radiation and convection from its exterior surface, there being no circulation of air through its parts. The surface must therefore be made larger if the motor is to be enclosed in order to carry away the heat, which otherwise would be dissipated by ventilation. In building an enclosed motor the armature, the commutator, the field magnets, &c., are made larger, and correspondingly more expensive, solely to get an increased surface of the yoke ring and covers. As a rule, the increased size gains nothing in the direction of a reduction of the heat generated within the machine, as is shown by the fact that enclosed motors are generally less efficient than open ones. It would seem to be a far preferable plan, says our exchange, to make the exterior of the motor with deep corrugations similar to those used for dissipating heat from enamel rheostats or theatre dimmers, or even more similar to the deeply corrugated rings of the cylinders of small unjacketed gasoline engines, such as are used in automobiles. These corrugations would greatly increase the superficial area of a given machine without increasing the size of its internal parts, and would almost correspondingly increase the heat which could be dissipated at a given temperature. Motors with deeply corrugated yoke rings of this kind are made by one enterprising house in Italy, and American manufacturers who now make their motors with practically a minimum ratio of surface to volume, would do well to consider this plan.

Institution of Electrical Engineers.—The opening meeting of the 1899-1900 session is to be held on Thursday, November 16th, at 8 p.m., when Prof. S. P. Thompson will deliver his inaugural address. The presentation of premiums for last session's papers will also take place on that occasion.

Appointments Vacant.—The Leyton Urban Council wants a shift engineer for the electricity works at £100 a year, and a chief assistant electrical engineer is wanted for Wigan at £120; also a foreman jointer. See "Official Notices."

Change of Address.—The address of the Northern Society of Electrical Engineers will in future be Fernholm, Barrington Road, Altrincham. All communications should be sent to Mr. Samuel Joyce, honorary secretary, at that address.

Surface Contact Traction.—The *Electrical World and Engineer* Paris correspondent reports that a contract has been completed with the owners of the patents of the Diatto electric traction system for the use of that system on all of the lines of the Compagnie Generale de Traction, which include 60 miles of railway track.

THE TELEPHONE SERVICE.

We publish below an order of the Postmaster-General under Section 3, Sub-section (5), of the Telegraph Act, 1899, defining the terms and conditions upon which inter-communication is to be allowed between competing telephone exchanges:—

Order of the Postmaster-General under Section 3, Sub-section (5), of the Telegraph Act, 1899.

Whereas it is enacted by Section 3, Sub-section (5) of the Telegraph Act, 1899, that if the license of an existing company (hereinafter referred to as "the company") is under the provisions of Section 3 of the said Act extended in respect of any exchange area for a period of not less than eight years the company shall, at the request of any other licensee of the Postmaster-General providing public telephonic communication in the whole or any part of that exchange area (which other licensee is hereinafter referred to as "the new licensee") and under such circumstances and on such terms and conditions as within six months from the passing of this Act may be prescribed by an order of the Postmaster-General made with the approval of the Treasury, afford all proper facilities for the transmission of telephonic messages between persons using the system of the company (either in the whole or in part of the exchange area, as the Postmaster-General may prescribe) and persons using the system of such other licensee, provided that the licensee so requiring intercommunication shall in any such case afford similar facilities:

Now, therefore, I, Henry, Duke of Norfolk, Her Majesty's Postmaster-General, by virtue of the powers vested in me for that purpose as aforesaid, and of all other powers vested in me in that behalf, do, with the approval of the Treasury, order as follows:—

1. When the subscribers of the new licensee at the date when inter-communication is requested equal or exceed in number one-fourth of those of the company at that date in the area specified in the new license, or number 500, whichever first happens, but not before, mutual intercommunication shall be afforded by the company, and the new licensee between their respective subscribers and other persons using their respective systems in the area specified in the new license only. Such intercommunication as aforesaid is hereinafter referred to as "restricted intercommunication."

2. In any case in which the company's exchange area, as defined by agreement with the Postmaster-General, exceeds in extent the area specified in the new license, then, when the subscribers of the new licensee at the date when inter-communication is requested equal or exceed in number one-fourth of those of the company throughout the whole exchange area of the company, at that date, but not before, mutual inter-communication shall be afforded by the company and the new licensee between their respective subscribers and other persons using their respective systems throughout the whole exchange area of the company. Such inter-communication as last aforesaid is hereinafter referred to as "unrestricted inter-communication."

3. The fact that restricted inter-communication exists with reference to the system of any new licensee shall not prejudice that licensee in requesting unrestricted inter-communication, and the two kinds of inter-communication may exist side by side on different terms.

4. The company and the new licensee may make terminal charges not exceeding the following:—

	Per call.
In the case of restricted inter-communication—	
(*a*) When the subscribers of the new licensee at the date when inter-communication is requested number 500, but are less than one-fourth in number of the company's subscribers at that date in the area specified in the new license	1½d.
(*b*) When the subscribers of the new licensee equal or exceed in number one-fourth (but do not equal in number one-half) of the company's subscribers for the time being in the area specified in the new license	1d.
(*c*) When the subscribers of the new licensee equal or exceed in number one-half of the company's subscribers for the time being in the area specified in the new license...	*Nil.*
In the case of unrestricted intercommunication—	
(*a*) When the subscribers of the new licensee at the date when intercommunication is requested equal or exceed in number one-fourth (but do not equal in number one-half) of those of the company at that date in the whole of the company's exchange area —in respect of intercommunication with the subscribers of the company and other persons using the system of the company in the portion of the company's exchange area which is not included in the area specified in the new license	1d.

Per call.

(*b*) When the subscribers of the new licensee equal or exceed in number one-half of those of the company for the time being in the whole exchange area—in respect of such intercommunication as last aforesaid ... ... *Nil.*

5. Any new licensee requesting facilities for intercommunication shall satisfy the Postmaster-General that such licensee possesses the required number of *bonâ fide* subscribers actually working.

6. When intercommunication has once been established—

(*a*) It shall be maintained, notwithstanding that the number (actual or relative) of the subscribers to one or other of the inter-communicating systems may subsequently fall below the number which would entitle a new licensee to request intercommunication, and

(*b*) No terminal charge shall be increased because the number (actual or relative) of the subscribers to one or other of the inter-communicating systems may fall below the number which first justified such charge, and

(*c*) if terminal charges have ceased, they shall not under any circumstances be reimposed.

7. The term "subscriber" means any person with whom the company, or the new licensee (as the case may be) has entered into an agreement for at least one year, for the purpose of enabling such person to communicate from time to time with other persons through the medium of an exchange, and does not include persons using call offices or an exchange.

8. This order may be cited as the Telegraph (Telephonic Intercommunication) Order, 1899.

Given under my Seal of Office this twenty-sixth day of September, 1899.

Norfolk,
Her Majesty's Postmaster-General.

Approved by the Lords Commissioners of Her Majesty's Treasury,
H. T. Anstruther.
W. H. Fisher.

Copies of the above order may be purchased either directly or through any bookseller, from Eyre & Spottiswoode, East Harding Street, Fleet Street, E.C.; or John Menzies & Co, 12, Hanover Street, Edinburgh, and 90, West Nile Street, Glasgow; or Hodges, Figgis & Co., Limited, 104, Grafton Street, Dublin.

NEW COMPANIES REGISTERED.

Royce, Limited (63,871).—This company was registered on October 17th, with a capital of £110,000 in £1 shares, to acquire the business of "F. H. Royce & Co., Limited," upon the terms of an agreement already prepared, to carry on the business of manufacturing electricians and mechanical engineers, to manufacture and deal in all machines, articles, and things required or used in the generation or utilisation of electricity, electrical energy, or other similar power, force, or energy, and to produce, accumulate, and supply electricity for the purpose of light, motive power, and otherwise. The first subscribers (each with one share) are:—F. H. Royce, Brae Cottage, Legh Road, Knutsford, Cheshire, electrical engineer; E. A. Claremont, Endsleigh, Legh Road, Knutsford, Cheshire, electrical engineer; A. W. Claremont, 4, Bloomsbury Square, W.C., solicitor; H. V. Whitehead, Redcot, Chorlton-cum-Hardy, engineer; R. D. Hulley, 11, Albert Road, Levenshulme, engineer; John De Looze, Rossall Mount, Hulton Street, Failsworth, Manchester, secretary; and J. H. Watkins, 1, Bradshaw Street, Moss Side, Manchester, electrical engineer. The number of directors is not to be less than two nor more than five; the first are Frederick H. Royce and Ernest A. Claremont (both permanent managing directors, special qualification 5,000 shares) and James P. Whitehead; qualification, £250; remuneration of managing directors £750 each per annum, others £100 per annum. Registered office, Cooke Street, Hulme, Manchester.

Blast Furnace Power Syndicate, Limited (63,875).—This company was registered on October 17th, with a capital of £100,000 in £1 shares, to acquire any inventions, processes, and rights relating directly or indirectly to the production, accumulation, transmission, distribution, or utilisation of power, whether mechanically, chemically, electrically, pneumatically, or otherwise, and to erect, construct, and maintain factories, machinery, furnaces, railways, &c. The first subscribers (each with one share) are:—Arthur C. Turtle, 26, Esmond Road, Brondesbury, N.W., clerk; Miss Edith M. Roberts, 20, Alkham Road, Stoke Newington; Charles H. Sims, 103, Endlesham Road, Balham, S.W., clerk; Alfred E. Tester, 1, Friern Road, East Dulwich, S.E., clerk; Thomas Welch, 30, Solon Road, Brixton, S.W., clerk; George H. Greer, 392, Hackney Road, N.E., clerk; and Henry Clifton, 5, Malvern Villas, West End, Aldershot, clerk. The number of directors is not to be less than three nor more than seven; the first are Frank L. Gardner, John J. Cooper, Charles Critchett, and Benjamin H. Thwaite; qualification, 500 shares; remuneration, £100 each per annum, and £100 extra for the chairman. Registered office, 32, Old Jury, E.C.

Phodyne Electrical Company, Limited (63,879).—This company was registered on October 18th, with a capital of £10,000 in £10 shares, to carry on the business of electrical engineers, electricians, engineers, contractors, suppliers of electrical and other power, and manufacturers of and dealers in electrical plant and machinery. The first subscribers (each with one share) are:—J. C. M. Stanton, 66, Victoria Street, S.W., engineer; H. A. Stevens, 9, Bucharest Road, Wandsworth, S.W., accountant; M. B. Hamilton, 3, St. John Street, Westminster, clerk; A. Barrengen, 143, Wightman Road, Harringay, N., clerk; M. E. Sheerboom, 6, Ferncliffe Road, N.E., clerk; G. J. Tindall, 1, Wellington Chambers, York Street, Westminster, clerk; and J. Renwit, 29, Hillside Row, Stamford Hill, N.E., clerk. Table "A" mainly applies. Registered office, 66, Victoria Street, S.W.

Manchester and Liverpool Electric Railway Syndicate, Limited (63,881).—This company was registered on October 18th, with a capital of £40,000 in £100 shares to construct, equip and maintain railways, on the monorail or other system, between Manchester and Liverpool or elsewhere, to work the same by means of electricity or other power, and to carry on the business of carriers of passengers and goods by land or water. The first subscribers (each with one share) are:—James H. MacMillan, 41, George Street, Manchester, calico printer; Edward Broadhurst, 56, Oxford Street, Manchester, manufacturer; Benjamin Armitage, 48, Moseley Street, Manchester, manufacturer; John B. Brooks, 92, King Street, Manchester, banker; George H. Gaddum, 7, South Street, Manchester, merchant; Alexander Wilson, 14, Cook Street, Liverpool, solicitor; John D. Crosfield, 6, Stanley Street, Liverpool, sugar merchant; William Oulton, Preeson's Row, Liverpool, shipowner; and William H. Vaudrey, 1, St. James Square, Manchester, solicitor. The number of directors is not to be less than seven nor more than nine; the subscribers are to appoint the first; qualification, five shares; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Column Printing Telegraph Syndicate, Limited (29,493).—This company's annual return was filed on August 29th, when 289 shares were taken up out of a capital of £25,000 in 500 £50 shares; £50 has been called upon each of the 189 and £8,940 has been paid, leaving £510 unpaid; 100 shares are considered as fully paid.

CITY NOTES.

Manchester Corporation Electricity Accounts.

The electricity supply undertaking of the Manchester Corporation is one of the largest and most important in Great Britain, and the figures which have to be dealt with in summarising the accounts, are of quite a different order to those which appear under the detailed headings of most undertakings. It may be interesting to compare the figures which indicate the state of the business for the first complete year (ending March, 1895), and those for the year just ended:—

	Units generated.	Units sold.	Number of public lamps.	Total maximum supply.
1894 ...	1,277,507	1,168,382	...	1,187 KW.
1898 ...	5,633,534	4,773,247	26	4,246 KW.

One statement recently made to us gives an idea of the kind of undertaking Mr. Wordingham is responsible for; it is that the number of boilers being put down, or in contemplation, reaches something in three figures, and the maximum load given above will, we suppose, be rapidly increased, as the immense areas surrounding the present supply district are connected up to the mains. In the report, the total length of main conductors laid is given at 130,457 yards equal to 74 miles odd, while 3,380 meters were in use at the end of the last financial year.

General Statement.

	1897.	1898.	Increase.
Total capital expenditure	£357,617	£493,716	£136,099
Number of units sold ...	3,434,850	4,773,247	1,338,397
Total maximum demand	3,776 KW.	4,246 KW.	470 KW.
Gross revenue	£56,148	£71,453	£15,305
Gross profit	£32,983	£40,935	£7,952
Average price per unit sold	3·80d.	3·48d.	—·32d.

The number of consumers is 2,570, and of motors 334, representing no less than 1,160 H.P.

Revenue Statement.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Sale of current	£54,397	3·80d.	£69,182	3·48d.	—·32d.
Meter rents	1,751	·12d.	2,240	·11d.	—·01d.
Supply of lamps	...	...	...	...	...
Sundry	...	...	31	...	...
Gross revenue ...	£56,148	3·92d.	£71,453	3·59d.	—·33d.

Since March 31st last the charge for the hire of electricity meters has been abolished, and it is proposed to still further reduce the charges for electricity supply. In May, 1897, a commencement was made in street lighting, the first instalment being 20 arc lamps in Albert Square, St. Ann's Square, and Piccadilly. Six more lamps have been added, but as plant becomes available, we presume the number will rapidly increase.

The costs are interesting, as showing what may be expected on a large scale. Reductions are shown on coal and wages, and slight increases (which balance the reductions) on oil, waste, &c., and repairs; the works' cost per unit remains therefore as before, at 1·11d. The total cost has fallen, however, nearly a tenth of a penny, due to a decrease under each item after works' cost.

Costs of Production.

	1897. Gross.	1897. Per unit.	1898. Gross.	1898. Per unit.	Increase.
Coal	£6,450	·45d.	£8,251	·41d.	−·04d.
Oil, waste, water and engine room stores.	2,316	·16d.	3,305	·17d.	+·01d.
Salaries and wages incurred in generation and distribution.	3,380	·24d.	4,383	·22d.	−·02d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	3,766	·26d.	6,113	·31d.	+·05d.
Works' cost	£15,912	1·11d.	£22,052	1·11d.	·00d.
Rent, rates, and taxes	2,474	·17d.	2,383	·12d.	−·05d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	2,652	·19d.	3,653	·18d.	−·01d.
General establishment charges, stationery and printing, law charges and insurance.	2,127	·15d.	2,430	·12d.	−·03d.
Other expenses	...	...	...	...	...
Total costs	£23,165	1·62d	£30,518	1·53d.	−·09d.

As regards profit, interest, and sinking fund charges together absorb nearly £5,000 more than in 1897, but the surplus has been such as to allow of £2,000 more being carried to credit of the rates and about £1,000 more to reserve fund, suspense account, &c, in 1898 than in the previous year.

Profit Statement.

	1897.	1898.
Interest on loans	£8,039	£10,572
Sinking fund for repayments	7,986	10,377
Net profit, carried to rates	10,000	12,000
„ being surplus, carried to reserve fund, suspense account, &c.	6,958	7,986
Gross profit	£32,983	£40,935

Brazilian Submarine Telegraph Company, Limited.

Mr. W. S. Andrews (chairman) presided over the fifty-second ordinary general meeting of the shareholders of the above company held on Wednesday at Winchester House, and, in moving the adoption of the report, said the income for the half-year, including the dividends from the Western Company and other companies, amounted to £119,360, and for the previous half-year it was £133,371, showing a decrease of £14,941. The falling off in the traffic receipts was far less discouraging than the figures would lead them to conclude. As a fact, the falling off had nearly all taken place in Brazil, where practically there was no competition to their lines. It really represented, he was sorry to say, the stagnation of trade which really existed in Brazil, although he was pleased to say that since the account was closed the report had been far more encouraging, and, therefore, he hoped to see a far more satisfactory account at the next meeting. The traffic to Uruguay had also undergone diminution, which appeared to be owing to the Uruguay merchants now doing their business to a very large extent through Buenos Ayres instead of telegraphing direct to Europe. They were, however, getting more commercial messages from Buenos Ayres, which was a very satisfactory feature, because at that place there was rather severe competition. With regard to Chili, there was not much to say, except that the bad trade there adversely affected their receipts. Turning to the expenditure, that was £21,999, against £22,253 in the previous year, or a decrease of £254. The outcome of this was that after providing £3,200 for debenture interest and sinking fund and £1,725 for income-tax, there remained a balance of £92,435. To this had to be added the sum of £15,801 brought forward from December 31st last, making a total of £108,236. Further expenses in connection with closer working union with the Western and Brazilian Telegraph Company, and the London Platino-Brazilian Telegraph Company, £635, and a quarterly interim dividend, amounting to £30,899 had been paid, and £20,000 transferred to the reserve fund. The directors now recommended the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income-tax, which, altogether, would amount to £51,639, leaving a balance of £5,062 to be carried forward. That was their usual dividend, and he thought that they might congratulate themselves that, in the face of somewhat adverse circumstances, they had maintained their dividend and their reserve fund, and were going on in the same prosperous way that they had hitherto done. The Lisbon-Madeira cable was faulty, but it continued to work satisfactorily nevertheless, and as they always acted on the principle of letting sleepy dogs lie, they had not interfered with it. The Lisbon-St. Vincent No. 2 cable gave way altogether, and they had to avail themselves of a ship of the Eastern Telegraph Company, which was near the spot, to restore it, and that had been done with very little outlay, and in a most satisfactory manner. The Chairman then proceeded to deal with the working arrangements which had existed between the Western and Brazilian Telegraph Companies, and said the arrangements for closer working had resulted very satisfactorily indeed, and the shareholders of the Western Brazilian Company had exchanged their shares for shares in the Brazilian Submarine Company to the extent of rather more than 95 per cent. When those arrangements were first brought upon the *tapis*, they were particularly careful to do nothing to offend susceptibilities of the Governments affected, and therefore they did not do anything in the shape of a complete consolidation of the two companies. However, their proceedings had met with the hearty approval of all, and they thought the time had now come for a complete arrangement for the consolidation of the companies. Notice had, therefore, been given to wind up the Western Brazilian Telegraph Company, and for the acquisition of the remaining properties of that company by the Brazilian Submarine Company. By that means they would obtain the collecting ground of the Western Brazilian Telegraph Company, and it should add greatly to their strength. The Governments had asked them to do certain things, but singularly enough the company had themselves intended doing those very things, believing that it would encourage trade and strengthen the concern. He had been asked whether wireless telegraphy would interfere with their company, and, he might say, that he did not think it would, although it was very well for short distances.

Mr. Frederick Youle seconded the motion, which was adopted.

Subsequently an extraordinary general meeting of the company was held, when various resolutions dealing with the acquisition of the Western Brazilian Telegraph Company were agreed to.

Cuba Submarine Telegraph Company.

The meeting of this company, held at 58, Old Broad Street, on Wednesday, was presided over by Mr. Parrish, who said the directors were very pleased to present such satisfactory results. The receipts for the half-year ending June 30th amounted, with interest on investments, to £25,027, while for the same period in 1898 they amounted to £33,594; but then, he explained to them, that such an abnormal increase was mainly due to the traffic arising from the continuance of the insurrection followed by the Spanish-American war. If they went back to the first half of 1897, they would find that the receipts amounted to £25,623, or very nearly the same amount as they were now dealing with, although the earnings from traffic were a little larger, and the interest on investments somewhat smaller. On the debit side of the accounts the working expenses were given as £7,257. In 1898 they were £8,091, and in 1897, £7,005. As compared with last year, the chief reduction was under the account of expenses at stations, and especially under the item of salaries and wages, which had been increased by payments to the staff for overtime and war allowances. Part of that reduction had been absorbed by other local expenses. The net result of the half-year was a profit of £17,769, of which they had placed £8,000 to reserve fund. The preference dividend amounted to £3,000, and the balance enabled them to propose a dividend on the ordinary shares at the rate of 6 per cent. per annum, and 1 per cent. bonus for the half-year. Comparing the balance-sheet with last year, they found that the spare cable in stock figured on June 30th 1899, at £2,908, while on June 30th, 1898, it was £4,559. The difference represented the value of the cable used in repairs and depreciation on that still in stock. It was possible they might find it advisable to send out some fresh lengths and increase the stock again. It was always well to have spare cable stocked for small repairs. The amount of investments had been increased to £117,059. In regard to the item "repairs to cables, &c., damaged during the Spanish-American war, £8,084," they were at present keeping this in the form of a suspense account. They were communicating with the Foreign Office as to their claim for compensation for the damage, and the matter was being laid before the United States Government. The question of their concession being formally recognised by the United States was still unsettled. A good deal depended upon the American policy with regard to Cuba. Some reports said that the Americans had no desire to remain in the island any longer than was necessary, but other reports pointed to a much more prolonged occupation. He said last April they were of opinion that the Spanish Government had treated them very fairly, and he had every expectation that they would eventually receive the amount then outstanding, but until it was actually encashed they preferred to leave it out of the receipts, although they had now practically agreed to the amount with the Government. He had the satisfaction of telling them now that his forecast was not misplaced. The amounts extended over several months of the war period, and it was unfortunate that the Spanish authorities had to leave Cuba before they were actually settled, but the company had copies of the account sent over to London, and sent Mr. Keith and Mr. Scott

to Madrid to explain the whole matter to the Government officials. They were kindly received, and he was glad to say that in a few days the account was settled, and the present half year's receipts will benefit by some £5,000 or £6,000, which they encashed. That was a very satisfactory outcome of the dealings with the Spanish Government. He had warned them that the receipts must be affected seriously by the lower rates which they had been compelled to charge by the competitions subsidised by the English and French Governments, and under the table giving a comparative statement of traffic, they had estimated the May and June receipts, which were generally poor months, at £2,000 each. He hoped that estimate might prove on the safe side, and that the actual traffics would be rather larger; but such figures must bring home very seriously the heavy loss that lower rates must cause them. The receipts for some time past had been swollen by Government accounts, which had now practically ceased. During the half-year the cables worked well, and were free from accident, but in July the Cienfuegos-Cape Cruz cable broke down. The fault had now been localised, and it would soon be in working order again. The Cape Cruz and Manzanilla cable also gave way, and was now being repaired.

The adoption of the report was seconded by Mr. KEITH.

After a few questions had been put and answered, the motion was carried, as was also the declaration of dividends and bonuses, moved by the CHAIRMAN, and seconded by Mr. R. KAYE GRAY.

The re-election of Mr. R. K. Gray as a director, and of the auditors, followed by votes of thanks to the board and staff, concluded the proceedings.

Western and Brazilian Telegraph Company.

THE ordinary general meeting of this company was held on Tuesday at Winchester House, Mr. W. S. Andrews presiding.

In moving the adoption of the report and accounts to June 30th, 1899, and the declaration of a 4s. interim dividend on the ordinary shares, the CHAIRMAN said that they were met for the purpose of the interment of the Western and Brazilian Telegraph Company in order that it might come to a fresh life and go on again prosperously with the Brazilian Submarine Company, and as one united undertaking. He briefly went through several items in the accounts in the usual way, showing the increases and decreases in expenditure and receipts, as compared with the corresponding period of last year. There was an apparent falling off in the receipts, but things had changed for the better, and this half-year traffic was going on much better. The falling off was due to stagnation of commercial affairs in Brazil, but that was now mending, and the future was satisfactory. The value of cable used for repairs was £5,093, and this had been charged to revenue. In consequence of this expenditure, instead of showing a considerable saving upon the ordinary expenditure, they showed an increase of £2,590. Cable accidents were beyond their control. The resolutions were adopted.

The meeting then became extraordinary, and passed, after a few questions had been answered, the following resolutions:—

1. That the conditional agreement made between this company of the one part, and the Brazilian Submarine Telegraph Company, Limited, of the other part, and dated October 18th, 1899, submitted to this meeting be and the same is hereby approved, and that the liquidator hereinafter mentioned be and he is hereby authorised to adopt the said agreement, and carry the same into effect with such, if any, modification therein as the said liquidator may think expedient.
2. That this company be wound up voluntarily, and that William Henry Axworthy be and he is hereby appointed the liquidator for the purpose of such winding up.

The resolutions will be submitted for confirmation as special resolutions to a second extraordinary general meeting.

Prospectus.—An issue has been announced this week by Chelsea Electric Supply Company, Limited, of £50,000 in 4½ per cent. debenture stock, ranking *pari passu* with £100,000 already issued. The price of issue has been fixed at 107 per cent. The total share capital of the company is £400,500, of which £200,500 is already issued and fully paid up. The object of the present flotation of debentures is to provide for the further development of the company's business.

Oriental Telephone and Electric Company, Limited.—The directors have declared an interim dividend of 4d. per share, free of income-tax, payable to those shareholders whose names are on the register at this date. The warrants will be posted 31st inst.

West India and Panama Telegraph Company, Limited.—The directors recommend a dividend for the six months ended June 30th of 6d. per share on the ordinary shares, tax free, carrying forward £380.

Castner-Kellner Alkali Company. Limited.—The directors have declared an interim dividend on the ordinary shares for the six months ended September 30th at the rate of 8 per cent. per annum, payable on November 1st.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending October 21st, 1899, were £325 2s. 0d.; receipts for week ending October 21st, 1898, £242 14s. 10d.; aggregate for half-year to date, £18,633 5s. 8d.

The Bristol Tramways and Carriage Company, Limited.—The receipts for the week ending October 20th, 1899, were £3,060 19s. 9d.; corresponding period, 1898, £2,566 2s. 6d.; increase, £494 17s. 3d.

The City and South London Railway Company.—The receipts for the week ending October 22nd, 1899, were £1,019; week ending October 23rd, 1898, £1,024; decrease, £5. Total receipts for half-year, 1899, £16,233; total receipts corresponding period, 1898, £16,275, decrease, £42. Miles open, 3½.

The Dover Corporation Electric Tramways.—The receipts for the week ending October 21st, 1899, were £187 19s. 11d.; week ending October 22nd, 1898, £184 0s. 2d.; increase, £3 19s. 9d. Total receipts to date, 1899, £8,463 4s. 1d.; corresponding period 1898, £6,984 9s. 8d.; increase, £1,478 14s. 5d. Miles of track open, 1899, 8; 1898, 8. Car miles run, 1899, 4,743, 1898, 4,251. Number of cars, 1899, 11; 1898, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, October 20th, 1899, were as follows:—D. U. T. Co., horse cars, £707 13s. 9d.; ditto, electric cars, £2,301 6s. 10d.; D. S. D. Co., electric cars, £726 18s. 3d.; total, £3,735 18s. 10d.; corresponding week last year—D. U. T. Co., horse cars, £3 271 13s. 2d.; ditto, electric cars, £313 9s. 2d.; D. S. D. Co., electric cars, £616 6s. 8d.; total, £3,201 9s. 0d.; increase, £534 9s. 10d. Aggregate to date, £70,835 11s. 11d.; aggregate to date last year, £68,515 2s. 9d.; increase to date, £2,320 9s. 2d. Worked:—The mileage open is 34 miles electrically, 10 miles by horses, as against 13 miles electrically, and 29 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending October 22nd, 1899, amounted to £1,571; corresponding week last year £1,376; increase, £195.

The South Staffordshire Tramways Company.—The receipts for week ending October 20th 1899, were £661 14s. 8d.; aggregate receipts for 42 weeks, £28,033 9s. 1d.; week ending October 21st, 1898, £638 10s. 3d.; aggregate receipts for 42 weeks, £26,559 13s. 0d.

STOCKS AND SHARES.

Wednesday Evening.

REPORTS of battles in South Africa, attended by satisfactory results to the British forces, have sent a thrill of excitement through the stock markets, such as has not been felt for many months past. That successful engagements at the commencement of the war would be the signal of a general advance, had been the opinion of the majority of members, but the boom which has actually occurred has caught many bears napping, and exceeded the most sanguine expectations. Something of this bullish sentiment, prevalent in other departments of the House, has been again noticeable in the electrical section, and particularly amongst the telegraph descriptions, where business has been brisk, and buying persistent. Anglo-American telegraph stocks continue to advance, and exhibit great strength. The Ordinary at 64 buyers, shows an advance of 3 points as compared with our last week's prices, the Preferred are 2 better at 114—115, while the Deferred have put on 1 at 16—16½. Buying of these has been very determined.

Eastern Telegraphs have been conspicuously in demand. Shareholders in this company may be interested to learn that it was mainly owing to the efficiency of their line that the news of the first victory against the Boers was cabled to London in the short period of 4½ hours. Eastern Extensions have attracted some attention, and are the turn of the market better at 14¼ buyers. Reuters are unaltered at 7—8. Indo-European Telegraphs have advanced 1, while other telegraphic descriptions are steady at last week's quotations.

The supply market has been rather neglected and there is little to report. Charing Cross & Strands are dull at 9½—10½, while St. James's and Pall Mall continue to show a sagging tendency at 14½—15½ in the absence of support. The new shares are about 30s. premium, and fractions can be sold for 2s. 6d. Next Saturday, by the way, is the latest date for sending in applications. The new shares are the cheapest thing in the electrical market at present, for besides being purchasable at £1 per share below the old issue, the renunciation letters enable a buyer to get the shares into his name free of stamp and fee.

Chelseas are unaffected by the issue of new debenture stock, which is to rank *pari passu* with the existing 4½ per cents. now quoted at 110 upwards. A small premium has been established upon the new stock, which is issued at 107, and the investment is a very fair one, yielding a fraction under 3¾ per cent. on the money.

Traction varieties keep very steady, with no particular feature. British Electrics at 17 fail to regain the 10s. which they shed last week, and the Preference are ¼ off. The company is making steady progress, however, and the fact that some of the English municipalities are taking electric traction into their own hands is not likely to militate against the success of the British Electric, which is breaking new ground in British Columbia and the Colonies. Barcelona Trams are unaltered in price, but the market are only buyers. No dealings are reported, as yet, in the new shares just issued.

The manufacturing section is remarkable only for a brace of rises which have taken place in the debentures of two of the leading companies. Henley 4½ per cent. Debentures and Callender's 4½ per cent. Debentures have both been sought after, with the result stated.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation, Oct. 18th.	Closing Quotation, Oct. 25th.	Business done during week ended Oct. 25th, 1899. Highest.	Lowest.
124,400l	African Direct Telegraph, 4 % Debs.	100	...	...	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, shares	10	...	...	...	3 — 4	3 — 4	...	...
125,000	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	85 — 90	85 — 90	...	...
905,560l	Anglo-American Telegraph	Stock	£2 13s	3 %	£3 9s	61 — 64 xd	64 — 67	65½	64½
3,047,220l	Do. do. 6 % Pref.	Stock	£5 6s	6 %	6 %	112 —113 xd	114½—115½	115	113½
3,047,220l	Do. do. Deferred...	Stock	...	...	18s. %	14¼— 14⅝	16 — 16½	16⅝	14⅝
205,151	Brazilian Submarine Telegraph	10	7 %	7 %	...	15 — 15½	15 — 15½	15⅝	15 1/16
75,000l	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	4 %	...	2½— 3	2 — 3	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	180 —190	180 —190	...	...
1,332,523l	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	102 —104	102 —104	103¼	102⅝
224,850	Consolidated Telephone Construction and Manufacturing	10/-	2 %	1½ %	1 %	¼— ¼	¼— ¼	...	...
16,000	Cuba Telegraph	10	8 %	7 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18½— 19½	19 — 20	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	103 —107%	103 —107%	...	...
60,710l	Direct United States Cable	20	3 %	3½%	3½%	11½— 12	11⅝— 12¼	12⅛	11 11/16
120,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	101 —104	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	6½%	7 %	7 %	149 —154	152 —157	155	150½
1,795,000	Do. 3½% Pref. Stock	100	...	...	...	99 —102	99 —102	100	99¼
89,900	Do. 5 % Debs., repayable August, 1899 ...	100	5 %	5 %	...	... ...	... ...	...	...
1,432,268l	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	118 —123	118 —123	121	...
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14 — 14½xd	14½— 15	14⅝	14⅜
16,200l	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	5 %	...	99 —103	99 —103	...	...
64,400l	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	5 %	...	100 —103	100 —103	...	...
320,000l	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	117 —122	117 —122	120	...
85,100l	Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	...	...	99 —103	99 —103	...	...
46,500l	Do. do. to bearer, 2,344 to 5,500	100	5 %	...	...	100 —103	100 —103	...	...
300,000l	Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909	100	4 %	...	...	101 —104	101 —104	...	...
200,000l	Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	4 %	...	...	102 —105%	102 —106%	...	...
180,227	Globe Telegraph and Trust	10	4½ %	4½ %	5½ %	10⅝— 11¼	11 — 11½	11¼	10 13/16
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6 %	15 — 15½	15¼— 15⅝	15⅝	15¼
150,000	Great Northern Telegraph, of Copenhagen...	10	10 %	10 %	...	30 — 32	29 — 31	...	...
89,500	Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	48 — 52	49 — 53	...	...
100,000l	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	6 %	...	106 —109	106 —109	...	...
71,000	Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 ...	1	...	...	...	¼— ½	¼— ½	...	...
84,000	Do. do. 5% Pref., Nos. 1 to 84,000	1	...	...	...	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	5½ %	6 %	6 %	5 — 5¼	5 — 5¼	5 3/16	5
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	5 1/16	...
1,329,471l	Do. 3½ % Deb. Stock Red.	Stock	3½ %	3½ %	3½ %	99 —102	99 —102	100	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	¾— 1	¾— 1	...	...
100,000l	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	4 %	...	103 —106	103 —106	...	...
11,839	Reuter's	8	5 %	5 %	...	7 — 8 xd	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132 xd	128 —133	...	...
58,000	United River Plate Telephone	5	5 %	6 %	...	4⅜— 5⅛	4⅜— 5⅛	...	...
151,783l	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	105 —108	...	...
200,000l	West African Telegraph, 5 % Debs.	100	5 %	5 %	...	99 —102	99 —102	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— 1	¼— 1	...	...
150,000	Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	102 —105	102 —105	...	...
389,521	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
88,321	West India and Panama Telegraph	10	1 %	⅛%	...	1¼— 1½	1⅜— 1⅝	...	...
34,568	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	6 %	...	10½— 10⅝	10½— 10⅝	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	6 %	...	8¾— 9⅛	8¾— 9⅛	...	...
80,000l	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	...	104 —107	104 —107	...	...
158,100l	Western Union of U.S. Telegraph, 6 % Ster. Bonds ...	100	6 %	6 %	...	98 —103	98 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	...	4 %	6 %	7½— 8½	7½— 8½	...	...
12,000	Do. do. 7 % Cum. Pref. ...	5	7 %	7 %	...	9 — 10	9 — 10	...	...
30,000	Charing Cross and Strand Electricity Supply	5	6 %	7 %	8 %	10 — 11	9½— 10½	10⅛	9½
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	...	...
84,000	*Chelsea Electricity Supply, Ord., ...	5	5 %	6 %	6 %	7½— 8½	7½— 8½	...	...
100,000	Do. do. do. % Deb. Stock Red....	Stock	4½ %	4½ %	...	110 —112	110 —112	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000 ...	10	7 %	10 %	6 %	11 — 12	11 — 12	11⅜	11
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12½— 13½	12½— 13½	13	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	125 —130	125 —130	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	nil	nil	10½— 11	10½— 11	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	13 — 14	13 — 14	13	...
220,000	Do. 4½% Deb. Stock, Prov. Certs (£30% to be paid) Rd.	...	...	...	...	81 — 84	81 — 84	82¾	...
26,100	Edmundsons Elec. Corp., Ord. Shares	5	...	5 %	7 %	5 — 5½	5 — 5½	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	3½— 4	3½— 4	3⅝	3 11/16
48,050	Do. do. do. 6 % Pref.	5	...	...	6 %	6½— 6⅝	6½— 6⅝	6½	...
100,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	105 —107	104 —106	105	104½
62,500	Metropolitan Electric Supply, 101 to 62,500	10	5 %	6 %	5 %	15 — 16	15 — 16	15½	15⅝
22,500	Do. Nos. 62,501 to 85,000	10	...	...	...	14 — 15	14 — 15	...	...
220,000l	Do. 4½ % First Mortgage Debenture Stock	...	4½ %	4½ %	...	117 —119	117 —119	...	...
6,452	Notting Hill Electric Lighting	10	4 %	6 %	6 %	15 — 16	15 — 16	...	...
31,980	St. James's and Pall Mall Electric Light, Ord.	5	10½ %	14½ %	14½ %	15 — 16	14½— 15½	15⅝	15½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 9½	9 — 9½	...	...
65,000	South London Electricity Supply, Ord., £4 paid	5	...	...	...	3⅞— 4⅛	3⅞— 4	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000 ...	5	9 %	12 %	12 %	14½— 15½	14½—15½	15½	...

* Subject to Founder's Shares.
† Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid.
‡ Dividends paid in deferred share warrants, profits being used as capital
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1896.	1897.	1898.	Closing Quotation Oct. 18th.	Closing Quotation Oct. 25th.	Business done during week ended Oct. 25th, 1899. Highest.	Lowest.
60,000	Aluminium "A" shares, Nos. 1—60,000	1	10 %	10 %	...	2⅜— 3¼	2⅜— 3¼	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	95 —100	95 —100	...	...
30,000	British Electric Traction	10	...	...	6 %	16½— 17½	16½— 17½	...	...
30,000	Do. do. 6 % Cum. Pref. 30,001—60,000	10	...	...	...	13⅜— 14¼	13⅛— 14	14 1/16	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	125 —128	125 —128	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	...	...	...	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ...	5	...	...	...	6½— 6⅝	6½— 6⅝	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	nil	3 %	5 %	1⅞— 2⅛	1⅞— 2⅛	1 15/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	4 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	2⅜	2¼
125,000l	Do. do. 4½ % Perp. Deb. Stock ...	Stock	...	...	...	109 —113	109 —113	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red. ...	Stock	...	...	...	104 —107	104 —107	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	10 %	12½ %	15 %	13½— 14½	13½— 14½	14	...
90,000	Do. do 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	112 —115	113 —116	116	...
35,250	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10 1/16
178,303	Do. do. do. £8 paid ...	10	...	...	...	...	...	...	...
61,033	Do. do. Pref. half-shares	5	...	...	...	4½— 5	4⅜— 5½	...	..
71,447	Do. do. Def. do.	5	...	...	...	5 — 5½	5 — 5½	...	...
630,000l	City and South London Railway	Stock	1 1/16 %	1⅛ %	2½ %	63 — 66	63 — 66	63½	...
22,500	Do. do. Ord. shares, Nos. 1 to 22,500 ...	10	...	...	...	6½— 6⅝	6½— 6⅝	...	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	...	...	3½— 4	3½— 4	3⅝	...
100,000	Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	...	...	...	...	100 —103	100 —103	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	5½ %	6 %	6 %	2 — 2½	2 — 2½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139	5	5½ %	6 %	6 %	4 — 5	4 — 5	...	...
344,023	Do. do. do. 4 % Deb. Stock Red. ...	100	...	...	...	95 — 97	95 — 97	...	...
112,100	Electric Construction, 1 to 112,100	2	5 %	6 %	6 %	2½— 2⅝	2½— 2⅝	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000 ...	2	7 %	7 %	7 %	3 — 3½	3 — 3½	...	...
140,300	Do. do. 4% Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	103 —106	103 —106	...	...
91,196	Elmore's Patent Copper Depositing, 1 to 70,000	2	...	...	...	¼ — ½	¼— ½	...	...
9,600l	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	11 — 13	11 — 13	...	...
15,000	Henley's (W. T.) Telegraph Works, Ord.	10	10 %	12 %	14 %	...	...	...	...
3,000	Do. do. do. 7 % Pref.	10	7 %	7 %	7 %	...	...	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½ %	4½ %	...	110 —113	110 —113	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	10 %	21 — 22	21 — 22	21⅝	21 1/16
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	100 —104	100 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	2½ %	3½ %	3½ %	8½— 8⅝	8 1/16— 8 1/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	13¼— 13⅜	13¼— 13⅜	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	37 — 41	37 — 41	39	37½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	103 —106	103 —106	...	...
13,400	Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ...	5	...	...	...	9¼— 9⅜	9¼— 9⅜	9⅝	...
13,400	Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000	5	...	...	...	5½— 6	5½— 6	...	...
540,000l	Waterloo and City Railway, Ord. Stock	100	...	...	3 %	101 —104	101 —104	101½	100

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
British Aluminium, Ordinary, 9—10; 7 % Pref., 9½—10½.
Brompton and Kensington, 4½% Debentures of £100, 104—107.
National Electric Free Wiring, 10s. paid, ¼—¼.
Smithfield Market Electric, 1—3.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12½—13½; 1st Preference Cumulative 6%, £5 (fully paid), 7½—8. Debentures, 105—107. Dividend, 1898, on Ordinary Shares 10%.
*T. Parker, £10 (fully paid), 18¾.

Bank rate of discount 5 per cent. (October 5th, 1899).

MARKET QUOTATIONS, Wednesday, October 25th.

CHEMICALS, &c.	This week.	Last week.	Increase or Decrease.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a " Nitric .. .. .. per cwt.	22/-	22/-	..
a " Oxalic .. .. .. per cwt.	32/-	32/-	..
a " Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	40/-	35/-	5s. inc.
a Ammonia, Muriate (crystal) .. per ton	£27	£25	40s. inc.
a " " .. .. per ton	£25	£23	40s. inc.
a Bleaching powder .. .. per ton	£6 10	£6 10	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. .. per ton	£16 10	£16 10	..
a Benzole (90 %) .. .. .. per gal.	7/-	7/-	..
a " (50/90 %) .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. .. per ton	£26	£26	..
a Lead, Nitrate .. .. .. per ton	£25	£25	..
a " White Sugar .. .. per ton	£31	£31	..
a " Peroxide .. .. .. per ton	£37 10	£37 10	..
a Methylated Spirit .. .. per gal.	2/9	2/9	..
a Naphtha, Solvent (90 % at 160° C.) .. .. per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8¼d.	8¼d.	..
a " Caustic (75/80 %) .. per ton	£24	£24	..
a " Bisulphate .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	68/-	68/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6	..
a " Recovered .. .. per ton	£5 10	£5 10	..
a " Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£7 10	£7 10	..
a " Crystals .. .. .. per ton	£3	£3	..
a " Bichromate, casks .. per lb.	2¾d.	2¾d.	..
METALS, &c.			
Aluminium Wire, in ton lots .. per ton	£224	£224	..
b " Sheet, in ton lots.. per ton	£191	£191	..
p Babbitt's metal ingots .. .. per ton	£90 to £160	£90 to £160	..
c Brass (rolled metal 2" to 12") basis per lb.	8¼d.	8¼d.	..
c " Tube (brazed) .. .. per lb.	10½d.	10½d.	..
c " Wire, basis .. .. per lb.	8½d.	8½d.	..

METALS, &c. (*continued*).	This week.	Last week.	Inc. or Dec.
f Ebonite Rod .. .. .. per lb.	3/-	3/-	..
f " Sheet .. .. .. per lb.	5/-	5/-	..
g Copper Bars .. .. .. per ton	£88	£88	..
g " Wire (basis price) .. per lb.	10½d.	10½d.	..
g " Sheet .. .. .. per ton	£88	£88	..
g " Rod .. .. .. per ton	£88	£88	..
n German Silver Wire .. .. per lb.	1/6	1/6	..
h Gutta-percha, fine .. .. per lb.	6/-	6/-	..
h India-rubber, Para fine .. per lb.	4/2½ to 4/5	4/2½ to 4/5	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i " Pig (Cleveland warrants) per ton	69/-	68/10	2d. inc.
i " Forgings, according to size per ton	From £11	From £11	..
i " Scrap, heavy .. .. per ton	50/- to 55/-	50/- to 55/-	..
i " Wire galvanised No. 8 .. per ton	£14 5	£14 5	..
g Lead, English Ingot .. .. per ton	£16 15	£16 15	..
g " " Sheet .. .. per ton	£18 10	£18 10	..
m Manganin Wire No. 28.. .. per lb.	8/-	8/-	..
g Mercury .. .. per bottle	£8 17 6	£8 17 6	..
d Mica (in original cases), small per lb.	2d. to 8d.	2d. to 6d.	inc.
d " " " medium per lb.	1/9 to 2/9	1/9 to 2/6	inc.
d " " " large per lb.	3/6 to 7/6	3/6 to 7/-	inc.
p Phosphor Bronze, plain castings per lb.	1/1 to 1/4	1/1 to 1/4	..
p " rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p " r'l'd str'p & sheet per lb.	From 1/2½	From 1/2½	..
o Platinum .. .. .. per oz.	£3 11	£3 11	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'g to desc'p'n p. ton	From £15	to £40	..
i Steel, Magnet, in bars	£58	£58	..
g Tin, block .. .. per ton	£149	£149	..
g " foil .. .. per lb.	1/9	1/9	..
n " wire Nos. 1 to 16 .. .. per lb.	1/11	1/11	..
p White Anti-friction Metals— "White Ant" brand .. per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. bundles pr lb.	7¾d.	7¾d.	..
j " Best Flax, 6 lea. .. per lb.	4½d.	4½d.	..
j " Hemp, 2 ply 10 lbs. .. per lb.	3¾d.	3¾d.	¼d. inc.
j " " Russian, 10 lbs. per lb.	4¼d.	4¼d.	¼d. inc.
j " Jute, 180 lbs. rove .. per ton	£13 10	£13 10	..
k Zinc, Sheet (Vielle Montagne bnd.) p.t.	£26 10	£27	10s. dec.

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

RAILWAY POWER DISTRIBUTION OVER LARGE AREAS.*

By A. H. ARMSTRONG, of the General Electric Company.

The formation of the International Traction Company brought under one management the various roads operating in Buffalo and the vicinity. Previous to this consolidation, each of the several roads had its own source of power, and the question of the most economical method of operating the entire system was of the greatest importance.

The Buffalo Railway had installed in its Niagara Street power house two rotary converters of the General Electric type in the fall of 1896, power being supplied by the Niagara Falls Power Company. Two additional converters had been added a year later, making a total nominal capacity of 1,600 KW. installed. This converter capacity, together with an engine capacity of 7,500 H.P., supplemented by a storage battery of 1,500-ampere capacity, had operated the lines of the Buffalo Railway Company.

To operate the enlarged system there were three courses open—increasing the capacity of the Niagara Street power house, building a new power house on the other side of the city to work in conjunction with the Niagara Street station, or the adoption of rotary converter sub-stations fed from Niagara Falls. The cars running to Niagara Falls and to Lockport were already partly fed from rotary converter sub-stations, and the enlargement of the Niagara Street power house would not contemplate the shutting down of these sub-stations. The operation of all the lines in Buffalo by a single power house was open to the serious objection that either a considerable increase in feeder copper would be necessary or boosters must be used. The amount of feeder copper installed provided for a number of feeding points into the system, and would have to be largely increased if the entire system were fed from a single point, as would be the case with one large power house. Heavier cars, equipped with electric heaters and operating at a much faster schedule are being installed, which would still further increase the amount of feeder copper required to such an extent that a single generating station was not looked upon as desirable.

The use of boosters as a permanent means of replacing feeder copper in a system where heavy overloads may be of long duration, is very objectionable, owing to the losses entailed. Overloads of short duration, and especially local overloads due to some special local event can very well be taken care of by boosters, but the cost of the energy lost in boosting daily overloads may be sufficient, as in the present case, to more than offset the interest on additional copper investment required.

The second method of operation, the building of another power house on the east side, was also open to serious objections. The capital investment called for in this case would have been still larger than that required for the additional copper with a single generating station, while the cost of operating two separate stations would have been greater than that of operating a single station of the combined capacity of the two. The required feeder copper also, while less than that for a single station, would be considerably greater than in the third method of operation, by rotary converter sub-stations.

The successful operation of a railway system, and especially one with suburban branches, calls for as high a schedule speed as can be maintained with safety.

It is, therefore, of paramount importance that the line voltage shall be kept up, as it not only ensures a good schedule being made, but results in less heating of the motors themselves. The rotary converter sub-station system permits sub-stations to be located wherever there is the greatest demand for power, as the comparatively small transmission line required can be carried underground to any locality, while the sub-station itself, requiring no boilers or engines, can be located in any neighbourhood, on account of its cleanliness and noiseless operation. The sub-station also requires a very small amount of floor space for its output, as compared with a steam-driven generating station, and hence can be located in the business districts where property is high, which, together with the cost of carting coal, would make a generating station in such a locality expensive to operate, especially as it must probably run non-condensing. The largest congestion of cars, and hence the largest demand for power, exists in the business districts, and it is the possibility of locating sub-stations close to the points of greatest demand that makes the converter system especially adapted to the operation of large city railway systems.

As sub-stations can be located where most needed, it is obvious that the amount of direct current feeder copper required for such a system is much less than would be required for the same effective operation with a single direct current generating station, while the high potential transmission line at 10,000 volts would demand but a small amount of copper.

The number of attendants in a sub-station need not exceed two men for a station having a capacity of, say, three 400-KW. converters, so that the labour account would be much less than in the case of a number of small generating stations.

The above advantages apply to the converter system whether the sub-stations are driven from a large steam-driven generating station, located in the outskirts of the city, and enjoying cheap coal and cheap real estate, or as in the Buffalo sub-stations, they are fed from a water-power station.

* Paper read at the New York Street Railway Convention, 1899.

After careful consideration of the several methods of operation open to them, Mr. W. Caryl Ely, president of the International Traction Company, and Mr. B. Van Horn, general manager, decided upon the adoption of the rotary converter sub-station system as offering the greatest advantages in its economy of operation and first cost of installation.

The method of operating the Buffalo City system, as adopted, involves the installation of five rotary converter sub-stations, besides the operation of the four converters and storage battery in the Niagara Street power house.

The steam plant at Niagara Street, however, will be shut down and kept as a reserve, thus permitting the entire lines of the International Traction Company in Buffalo, Niagara Falls, Tonawanda, and Lockport to be driven from rotary converters fed by the Niagara Falls power.

There will be a total of six sub-stations, including Niagara Street No. 6, having the following maximum output during the winter months, when heaters will be used:—

	Maximum output.	Converter installed.	Ultimate capacity.
Sub-station No. 1 ...	760 KW.	800 KW.	1,200 KW.
" " 2 ...	870 "	800 "	1,200 "
" " 3 ...	1,230 "	1,200 "	1,600 "
" " 4 ...	870 "	800 "	1,200 "
" " 5 ...	890 "	800 "	1,200 "
" " 6 ...	1,600 "	1,600 "	1,600 "
Total ...	6,220 KW.	6,000 KW.	8,000 KW.

The peak of the load is somewhat in excess of the rated capacity of the converters to be installed, but the storage battery in the Niagara Street station has been increased to 3,000 amperes capacity, and this will be used to take the peak of the load, the ultimate capacity of the station providing for reserve apparatus and increase of traffic.

These six sub-stations will feed into a common feeder network through automatic circuit breakers, the load being taken on the larger stations during light traffic at night. The composition of the various sub-stations will be similar in all respects, with the exception of sub station No. 6, which is located in the present Niagara Street power house. The other stations differ only in the number of rotary converters of 400 KW. capacity contained in each, the entire apparatus being furnished by the General Electric Company.

Sub-station No. 1 contains two rotary converters of 400 KW. capacity, with an ultimate capacity of three converters, each converter being fed through three step-down transformers of 150 KW. each, reducing the line potential of 10,500 volts to 375 volts, corresponding to 600 volts on the direct current side of the converters. These transformers are of the air blast type, and feed directly into the rotary converters, the controlling switches being placed in the primary circuit.

The converters, being of the three-phase type, enable the step-down transformers to be connected in delta, so that the disabling of one transformer of a set does not throw the converter out of service. In addition to the individual switch controlling each rotary converter with its transformers, there is a main emergency switch opening the high potential bus bar circuit of the sub-station in case of necessity, where it is desired to throw out the entire station at once.

Artificial reactance is introduced between transformers and converters to enable the converters to regulate with varying loads, this reactance also being cooled by artificial air draught, for which purpose direct current blower sets are provided in duplicate, and feed into a common air chamber, from which individual transformers and reactances draw their supply.

In a large railway system of this character it is desirable to provide a ready means of starting the converters that will be effective and require a minimum time. While any one sub-station is in operation, it is, of course, possible to start the converters of a second sub-station from the direct current side, and suitable starting resistances are provided for this purpose. This can only be satisfactorily accomplished, however, when traffic is very light, and the line voltage high.

A possible shut down may occur during a time of maximum load, when it would not be desirable to start several sub-stations from the alternating current end of the converters, owing to the large lagging current affecting the regulation of the system. To provide an efficient method of starting, there has been installed in two sub-stations a starting set, consisting of an induction motor direct coupled to a direct current generator of sufficient capacity to start one converter.

This method permits the starting of the converters in these stations from the direct current end, which will ensure bringing them into synchronism in a minimum time with the right polarity. The converters in adjacent sub stations can then be started from the direct current feeder system.

By sub-dividing the city into several sections, each fed from a separate sub-station, the present amount of direct current feeder copper need not be increased to any considerable amount, especially as the track joints are being welded, thus making the ground circuit exceedingly good. With the completion of the different sub-stations, the International Traction Company will have in operation a model railway system, having sub-stations fed from a single generating station as a source of power, cars using electric brakes operating over tracks with welded joints, and high-speed suburban lines to the several adjacent towns.

VOLTA AND THE VOLTAIC CELL.*

Prof. Righi, in an elcquent discourse delivered at Como in connection with the Volta centenary, gave an account of the character and scientific work of Volta, which deserves to be widely read. It is too long to be translated *in extenso* in our pages, but some of the more important passages may be read with interest.

The lecture was divided into five sections, with a preface, a conclusion, and an appendix. The sections deal with the condition of electrical science before Volta's time, Volta's work, other than that in connection with the pile, the discovery of the electricity of contact, the discovery of the pile, and the theory of the pile. The appendix, an essay on the theory of the pile, is an important contribution to this apparently interminable controversy.

Born in Como in 1745, Alessandro Volta, when little more than a boy, took for the subject of his poetical compositions the electrical experiments then in vogue, and the observations made by De Saussure on Mt. Blanc. These show that he was already well versed in these subjects, and of them he sought to improve his knowledge, by maintaining an active correspondence with the Abbé Nollet, and other contemporary physicists. He was led, in short, to investigate electrical phenomena for himself, and when scarcely 24 years old, dedicated his first memoir "On the Attractive Force of the Electric Fire," to Beccaria, of Turin. This was followed, two years later, by another addressed to the celebrated Spallanzani.

In reading these papers, and particularly those which led him to the invention of the electrophorus, everyone must be struck with the singular acumen with which he took account of every detail of his experiments, and with his great capacity for concentrating attention upon the favourable circumstances. Volta was led to the electrophorus by his attack on the theory of the so-called "electricita vindice," proposed by Beccaria to explain certain phenomena which had been observed by himself, and by Wilke, Epino, and Cigna.

We know that, according to this theory, an electrified insulating plate placed in contact with a non-insulated conducting plate is deprived of electricity, and that on separating the two plates the first recovers the primitive charge, leaving on the now insulated conducting plate a charge of the opposite sign. Volta showed clearly that, instead of this being the case, the insulated plate retains its charge throughout unchanged, and that this induces an opposite charge on the conducting plate. The adhesion of the plates to one another during the period of contact confirmed Volta's explanation, and it only remained to give suitable forms and dimensions to the two plates, and to put a third conducting plate under the insulator to construct the electrophorus.

To Volta we owe the discovery of the production of the so-called "inflammable air" by the decompcsition of organic bodies. He was the first to explode this gas mixed with air, and free from hydrogen, in a closed vessel by an electric spark, and was thence led to the invention of the gun and pistol still known by his name, of the eudiometer, now universally used in the analysis of gases, of the hydrogen lamp, and of the apparatus which, four years later, enabled Cavendish to effect the synthesis of water.

An observation made by the illustrious Arago in the course of a eulogy of our great physicist delivered before the Academy of Sciences, of Paris, may be aptly quoted here. He observed that "Volta possessed, in the highest degree, two qualities which are rarely united in one man. The genius that creates, and the spirit that applies. He never abandoned a subject until he had considered it under every possible aspect, nor without having described, or at least suggested, instruments which might be employed by science, by industry, or even by mere curiosity." We have a good example of this in a proposal suggested by his own discovery, and made by him in a letter addressed in 1777 to Prof. Barletti. He proposed to fire an electrical pistol at Milan by the discharge of a Leyden Jar at Como, the two being connected by a pair of iron wires, or alternatively by a single wire and a canal of water.

In this project, which, so far as is known, was not carried out, can be recognised the germ of modern electrical telegraphy. So the germ of the idea of gas lighting may be traced in a proposal made by Volta to Father Campi to employ natural inflammable gas in lamps instead of oil. Perhaps, too, the electrical pistol may be looked on as the first of the modern gas engines.

Of Volta's stern adhesion to strict scientific method, and his condemnation of fanciful speculation, or merely sensational experiment, Prof. Righi has much to say. "What possible good," Volta wrote, "can come out of all this, unless the observations are reduced to scale and measure, and especially in physical science? What is the use of ascertaining a cause unless the quantity and intensity of the effect is determined, as well as its character or quality." It was in obedience to this method that he was led to transform Nollet's thread electroscope, and Cavallo's pendulum electroscope, into measuring instruments, by the construction of the straw electroscope, which he took pains to calibrate by ascertaining the relation between the deflections and the corresponding tension, to use the word then in vogue.

The great success of his teaching at the University of Pavia is attested by Arago, who said that "the pride and pleasure of being able to call oneself a pupil of Volta contributed largely for more than 30 years to the great success of the University on the Ticino."

It was after his appointment to the professorship that Volta composed and published his memoir on the condenser. With this he was able to show the existence of electricity in circumstances in which the straw electrometer by itself was useless, such, as for instance, in his experiments on the electricity of contact. We may recall, too, the experiments made by Volta at Paris, in collaboration with Lavoisier and Laplace; and in London with Bennett, Magellan Cavallo, and other members of the Royal Society, designed to show the production of electricity by the evaporation, the combustion, and the expansion of gases, though modern opinion on the causes of this electrification differs from that which was expressed by Volta and others of his contemporaries.

Another good example of the application of the electrometer, combined with a condenser, is an experiment made by Volta on the nights of July 28th and 29th, 1780, when the sky was illuminated by an exceptionally brilliant aurora; and this is an especially good instance, because it illustrates his extreme caution in drawing conclusions from observation. On these nights, by connecting a condenser and electrometer to an aerial wire he obtained certain evidence of electrification, and even small sparks. This appeared to prove the aurora to be certainly an electrical phenomenon. But later on he did not consider himself justified in considering the point rigorously proved, and writing nine years later to Dr. Bondioli, the author of a paper on the aurora, he declared himself certainly inclined to believe in the electrical nature of the phenomenon, and recognised the similarity between its appearance and that of the electric discharge in exhausted gases; but at the same time he uttered a warning in criticism of those who, he said, "are infatuated with electricity, and see electric fire in every spark and every flame in heaven and earth."

To the phenomena of natural electricity Volta gave many years of study, and published the results in his famous letters on meteorological electricity addressed to Prof. Lichtenberg, of Gottingen, and in a long memoir on hail published by the National Italian Institution. These letters show most clearly that, while occupied with such arguments, he had constantly in his view the introduction of accurate measurement into his researches at every possible opportunity. With the desire of making the indications of different electrometers mutually comparable, and of founding a general system of graduation analogous to that used in themometry, Volta proposed, in the first of the letters referred to above, to determine, by means of a balance, the equilibrium between known weights and the electrical force acting on a metallic disc suspended from one of the arms. But one step, though a very important one, was required to bring this arrangement to the modern guard ring electrometer of Lord Kelvin.

The action of flame in the discharge of an electrified body, similar to that of an innumerable number of sharp points, was discovered by Volta in 1787, and was of undoubted service in his study of the electrical phenomena of the atmosphere; and though its employment as a discharger is not usually convenient, yet recourse is still had to the flame, which presents some advantages in cases of rapid electrical variations, or of imperfect insulation. This use of the flame is treated fully in the letters to Prof. Lichtenberg, and some interesting experiments are described, which might lead to other special applications of it. In one of these experiments, which is little known, having dissipated by the use of a flame the charge of a Leyden jar into the air of a room, he afterwards, by the same means, succeeded in collecting part of it into a new jar.

The theory of hail proposed by Volta, which attributes the freezing to the cold produced by rapid evaporation, is, in its general lines, still accepted, and the ingenious hypothesis of the electrical dance of the little hailstones between two oppositely electrified clouds, invented by Volta to explain their gradual formation and prolonged suspension, though now considered insufficient, cannot be treated as absurd.

Volta has left deep footprints in other fields of research. De Lue, Roy, De Saussure, Lambert, Berthollet, Amontons, and other accomplished physicists who were occupied with the important study of the dilatation of gases, had obtained discordant results. Volta's fine intuition divined that the cause of the discrepancy was the presence of water vapour, which was mixed with the air in many of the experiments. Having eliminated this he obtained consistent results, which enabled him to formulate the laws of the proportionality between the increase of pressure of a given volume of air and the rise of temperature which produces it. He recognised, moreover, that air which contains a constant quantity of vapour behaves like dry air, and justly concluded that water vapour itself behaves like air. Finally, the postscript of a letter to Vassalli asserts that the quantity of vapour, formed in a given limited space is the same whatever may have been the space originally occupied, and however much air it may contain. Gay Lussac and Dalton confirmed these results by numerous experiments, and were able to announce anew the laws which to-day bear their names.

So far the extracts from Prof. Righi's address are taken from the part dealing with Volta's work which did not bear on the discovery of the pile. Those now following refer to Galvani's discovery.

Eight years older than Volta, Galvani's labours had already secured for him a wide and ungrudged reputation, though his habitual delay in publishing his observations led in some cases to the harvest of his honours by others. A survey of his existing MSS. shows that before 1780 he was occupied with the researches which led him to his famous experiment, and that before 1791, the year of publication of his masterly work, "De Viribus Electricitatis in Motu Musculari Commentarius," he had already prepared several accounts of his experiments, and had refrained from publishing them.

After it had been made evident that the lively muscular contraction of the frog, prepared in the classical manner which bears Galvani's name, constitutes an electroscope of immense sensibility, capable of detecting not only the feeblest charges of artificial electricity, but even of atmospheric electricity, Galvani occasionally observed the same contraction in special circumstances where the usual provocative cause was wanting. This singular fact could not fail to attract the attention of so acute an observer as Galvani, and, to put it shortly, by taking account of the condition necessary for its occurrence, he recognised that it was nothing more than the existence of a metallic connection between the lumbar nerve of the frog and the muscle of

* A lecture delivered in Como, September 18th, 1899, by Prof. Augusto Righi.

the thigh. In fact, it was sufficient to touch these two points of the body of an animal with the ends of a wire to provoke lively contractions, similar in all respects to those effected by the high tension of the electrostatic discharge.

Galvani's experiment, repeated everywhere with success as soon as it was made known, occasioned profound sensation. That Volta was among the first to occupy himself with it appears from a letter to Dr. Baronio of April 3rd, 1792. Not satisfied with verifying what he himself termed "the stupendous discovery of Galvani," he varied the conditions of the experiment in many ways, and applied himself to ascertaining the smallest discharge sufficient to cause the contraction, substituting for the simple wire a Leyden jar whose charges were measured by drawing them from another jar of known capacity. A few accurate and methodical experiments established the important fact that contraction was more lively if the lumbar nerve was connected to the positive armature and the muscle to the negative than in the reversed arrangement. Absorbed by interest in the new phenomenon, Volta for many years could not abandon its study, and, indeed, within a few months published a first memoir on animal electricity, followed soon after by another. Reading the limpid description of his innumerable ingenious experiments, one can follow step by step the laborious logic of his thought, and understand how by slow steps that mental evolution was accomplished which converted the admirer and supporter of Galvani's hypothesis into its opponent, and gave birth to the theory of contact.

His first experiments, in fact, seemed to corroborate Galvani's hypothesis, and his first memoir opens with a passage which does not less honour to the writer than to him of whom it was written. "The dissertation published by Dr. Galvani, of the Institute of Bologna, and professor in that university, who is celebrated for other discoveries in anatomy and physiology, on the action of electricity on muscular motion contains a great and luminous discovery which deserves to mark an epoch in the annals of physical and medical science, not only, nor so much, on account of its novelty, as for the fact that it opens a wide field for research, equally interesting and curious, and of the most valuable application. The third part of this work proves, by the evidence of many experiments, well combined and accurately described, that there exists a true and real animal electricity, that is to say, electricity excited by the living organs themselves."

It was in the course of these experiments on Galvani's discovery that Volta found the action of a circuit of two dissimilar metals to be greatly superior to that of a homogeneous circuit in its effect on the muscle.

Galvani's own experiments, described in the second memoir, showed that the muscular contraction was a secondary effect of the excitement of the nerve. Led by this to experiment on the nerves of sense, he discovered the curious effect of taste produced by the contact of two different metals applied to the tongue, an effect which, though unknown to him, had been described 25 years before by the Swiss philosopher, Sulzer, a member of the Academy of Berlin, in his "New Theory of Pleasures."

Gradually his suspicion assumed a more definite shape, and in letters addressed to Tiberio Cavallo, Volta declared himself to be persuaded that the phenomena observed by Galvani and himself were mainly due, not to animal electricity, but to a very weak artificial electricity produced in some way, not understood, by the contact of dissimilar armatures. At the same time, with admirable prudence, he added that certain effects, such as that of the contraction produced by a homogeneous wire, still appeared to be certainly due to animal electricity.

One point is worth special remark. He perceived at this stage that the electrical want of equilibrium was due, not to a momentary electrical flow like the discharge of a condenser, but to a continuous phenomenon, to designate which he began to use the term *current of electricity*. This conception naturally suggested new and varied experiments, which led him at last to exclude all animal electricity, and to formulate more and more clearly his own hypothesis.

What do you think, begins one of his letters to Vassalli, of the supposed animal electricity? I, myself, am continually more convinced that the whole action proceeds originally from the combat of two metals with one wet body, or with water itself, and that in virtue of this combat, the electrical fluid is thrust forward by the metals themselves into the wet body, or into the water, in some cases more, in others less actively (most actively of all in the case of zinc, least of all in the case of silver), and that by this an uninterrupted flow is induced through suitable conductors, and the fluid is drawn in a continuous circuit.

As may be supposed, the supporters of animal electricity descended into the field, and accumulated experiments tending to establish their hypothesis. Among these Aldini and Doctor Eusebio Valli distinguished themselves by their bravery and activity. On his side Volta opposed new experiments and forcible arguments to those of his adversaries, and the famous battle, waged with ardour, but never without courtesy, spread beyond the borders of Italy, and lasted many years. The spectacle was of extreme interest. Victory seemed to belong now to one side, now to the other, as a new fact or an ingenious argument changed the fortune of the combatants; but so great was the admiration excited by the valour of both, so evident was the love of truth by which all were animated, that no partisanship or hope of victory for a particular side was anywhere evolved.

The first and most important objection to Volta's view was the experiment with the conductor composed of one metal, and his reply to this was that the homogeneity was only apparent, and that small variations of temperature and other circumstances were sufficient to produce the effect.

Why have recourse, exclaimed Volta, to the supporters of animal electricity, to a principle, purely hypothetical, of a natural want of balance of the electric fluid in animal organs? This is merely a useless multiplication of the causes of the action by adding others of the same kind as the effects produced. Let us stand by that which has been directly and indisputably proved, and not be carried away by conjectures and hypotheses, which may be elegant and attractive, but are hardly ever successful, and are useless if they do more than express the results of the most simple and clear experiments.

When once it had been established that an electromotive force exists between two wet conductors of the second class (electrolytes) in contact, it became impossible for the supporters of the hypothesis of Galvani to entirely exclude the intervention of contact electricity and the famous controversy began at length to languish.

The section of Prof. Righi's address dealing with the invention of the pile begins thus:—

Alessandro Volta's noble intellect shone nowhere so brightly as in his researches on contact electricity. A lively imagination, controlled at all times by the coolest judgment, a serene spirit in the face of difficulties, which compelled him to modify his ideas; a penetrating sagacity in contriving experiments, and unequalled skill in their execution; sane reasoning power in the interpretation and collation of facts, and in drawing conclusions from them—these were the salient characteristics of his lofty mind.

We all know how the new discovery (of the pile) astonished the world, what an outburst of admiration it produced, what well-merited honours it earned for Volta. And truly the impression produced cannot have been otherwise than it was—prodigious. Since then we have been able, with extremely simple means, thanks to the pile, not only to produce many of the effects of the discharge of electrified bodies, but to obtain entirely new and unexpected results. Moreover, those previously known have a special character when produced by the pile, which renders them more useful or more interesting than before.

The researches which led Volta to the invention of the pile furnished him with the victorious weapon for a final combat with those who persisted in thinking the so-called galvanic fluid to be something different from the electric fluid, the supposed cause of electrical phenomena. In his first memoir on "The Identity of the Electric Fluid and the Galvanic Fluid," Volta most completely summed up the famous controversy and expounded his own theory. A distinguished nephew of the great Comascan has happily said that this is "a stupendous work, rich with new experiments and subtle arguments," and may be looked on as "his literary testament." The adventures of this memorial are curious and instructive. In 1805 a scientific society offered a prize for competition, inviting men of science *To expound clearly, with dignity and without offence to any one, the question of galvanism at issue between our distinguished members Signor Giovanni Aldini and Signor Alessandro Volta.* The prize was not awarded to any one of the three competitors, and the sealed envelopes which contained the author's names were burned. But one of these competitors was Alessandro Volta, and the work presented by him was this ponderous memoir. Nine years afterwards Configliacchi, Volta's successor in the chair of physics at Pavia, published the work in such a way as not to make it understood that he was not the author, and when long afterwards he composed a bombastic eulogy of Volta, he omitted this memoir from the list of his published works. Since then we have obtained evidence, now irrefragable, that the memoir really came from the pen of Volta.

In this victory (the discovery of the pile) luck had no part. It was the result of a long series of sagacious researches and ingenious experiments inspired by consecutive logical deduction. Thanks to the pile, electricity has ceased to be merely an object of scientific interest, and has become a weapon of research, powerful, far reaching, catholic. By its aid science has developed for mankind a multiform mode of energy which seems destined to produce a profound revolution in human affairs only comparable to that produced in remote ages by the use of fire.

Towards the end of 1792, soon after the discovery of Galvani, a distinguished Italian chemist, Giovanni Valentino Fabbroni, had attributed the muscular contraction of the frog to a chemical phenomenon. He had studied the effects produced when two different metals, immersed in a liquid, are placed in contact, and had recognised that these, which consist principally in the oxidation of a metal, do not occur unless the metals are in contact. According to Fabbroni, the moist body of the frog fills the place of the liquid in respect to the two metals of the conducting arc, and the contraction is due to the chemical action caused by their contact. At the same time, Fabbroni showed that he was inclined to admit the production of electricity as a secondary effect. Afterwards Gautherot adopted this last supposition, and asserted that the chemical action was the true cause of the electrical phenomena which Volta had attributed to simple metallic contact. This idea, adopted by Wollaston, Nicholson, and others, was generally elaborated and completed, and gave rise to the modern chemical theory of the Voltaic cell.

The chemical decomposition of electrolytes, which Nicholson, Carlisle, Vassalli and others effected by making the liquid form part of the circuit connecting the poles of the pile, soon showed that an intimate connection exists between the two kinds of phenomenon, and strengthened the chemical hypothesis. And although the theory of Grotthus and the laws of electricity formulated by Faraday and by our own countryman, Matteucci, have established that the electrolysis of the liquid and the passage of the current are inseparable phenomena, an explanation of the action of the pile can, nevertheless, be still based on Volta's contact theory.

And to-day, whether we attribute the starting of the action of electrolysis to chemical affinities existing between the several metals and the electrolyte, or to the electrification of metals by their mutual contact, and whether, in consequence, we formulate a theory of the pile on the chemical or on the contact hypothesis, it will not be possible to establish the truth of the former, as against the latter theory, except by a direct proof, that no electricity is produced by simple contact between heterogeneous substances.

Generally speaking, a new theory which penetrates the surface of the hidden causes of phenomena may thrust a little farther back the limit between the known and the unknown, but cannot gives us a view of the first cause. At present it seems possible to base an explanation of the phenomena of the pile on the conception of floating atoms, or groups of atoms, integral parts of the molecule, whose electrical charges they bear; and it may seem possible to extend the principle of this explanation to other electrical phenomena. But supposing we succeed in doing all this, shall we have explained everything? Certainly not. We come then face to face with the question: In what does the electrical charge of an ion consist?

Indeed, we have as yet no precise idea of what the electrical charge of a body or atom may be. The intimate nature of that electricity whose masters we are, which we use in a thousand ways, from which this dying century may draw its characteristic designation, is still a mysterious sphinx defying us from afar. But it is not possible to feel discouragement while we are speaking of Volta. The great progress made in electrical science in our age gives us confidence in future victories, perhaps far greater than those already won. That this progress is mainly due to the pile is the chief glory of Volta. But with this honour he possesses another, that of having restored to our system of research the rigorous experimental method which had been taught by Galileo, from which we had wandered. By keeping our attention on the example of these great leaders, as beacons lit to guide our way, we shall certainly succeed in making the longed-for progress, and shall continually approach an intimate knowledge of the nature of electrical phenomena.

ELECTRIC TRACTION IN SOUTH STAFFORDSHIRE.

From the brief notes which have come to hand from time to time from South Staffordshire, it has been clear that the British Electric Traction Company has been pushing forward with a scheme of great importance in that particular part of the country. Of course, everyone is fully acquainted with the enormous amount of pioneering electric traction work that has been done by this company all over the country during recent years, but it seems to us that if municipal enterprise (hindrance to enterprise we should call it in this instance!) is kept within its proper limits, its South Staffordshire undertakings promise to rank as the most extensive and important of all. The industrial importance of the district lying between Birmingham and Wolverhampton, and between Walsall and Stourbridge, otherwise known as the "Black Country," is recognised by everyone.

The density of population is as shown by the following figures (1891 census), and all the towns mentioned are contained within an area of some 60 or 70 square miles:—

Bilston	23,453	Quarry Bank	6,732
Brierley Hill	11,881	Rowley Regis	30,791
Coseley	21,899	Sedgley	14,961
Darlaston	14,422	Smethwick	36,170
Dudley	45,740	Stourbridge	14,901
Halesowen	14,481	Tipton	29,314
Handsworth	32,756	Walsall	71,791
Kingswinsford and Amblecote	20,724	Wednesbury	25,342
Lye and Wollescote	10,165	West Bromwich	59,489
Oldbury	22,607	Willenhall	16,852
		Wolverhampton	82,620

At the present time (1899) the total population of the area considerably exceeds half a million, and the districts are controlled by no less than 22 local authorities.

A complete system of intercommunication admitting of convenient and rapid transit from place to place is of paramount importance to such an aggregation of busy industrial towns.

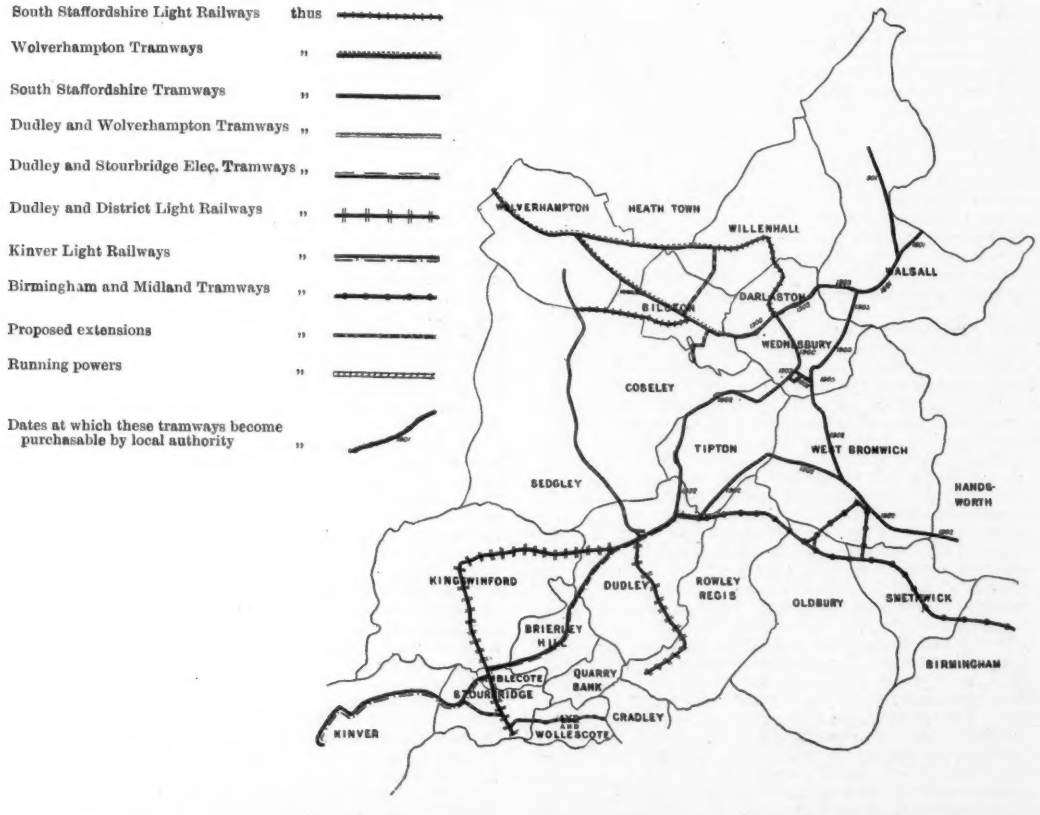
The extent to which this was possible before the British Electric Traction Company appeared upon the scene can be judged from the map given below.

The district is at present served by the following tramway companies:—

Company.	Worked by.	Length of route.	Gauge.
South Staffordshire Tramway Company.	Partly steam, partly electricity	22¾ miles.	3 ft. 6 ins.
Dudley, Stourbridge and District Electric Traction Company.	Electricity.	5¾ „	3 ft. 6 ins.
Birmingham & Midland Tramways Company.	Steam.	11 „	3 ft. 6 ins.
Dudley & Wolverhampton Tramways Company.	Steam.	5¾ „	4 ft. 8½ ins.
Wolverhampton Tramways Company.	Horses.	8¾ „	4 ft. 8½ ins.
		54 miles.	

The lines of these companies are not only quite inadequate in extent for the needs of the travelling public, but are, moreover, entirely separated and disconnected; two of the companies actually having a different gauge to the rest of the tramways in the district, thus making any through communication quite impossible, even if there were joint management.

In such a disjointed system as this, even if the tramways were all that could be desired in regard to comfort, speed, and frequency of service, the inconvenience of changing cars would prevent their being of any great benefit to the community at large; but the inconvenience is aggravated to such an extent by infrequent service and insufficient accommodation that the whole tramway conditions of the district cannot be described as otherwise than thoroughly unsatisfactory.



The public, not unnaturally, only use the cars when forced to do so by the lack of better means of conveyance, and the tramways cannot be made to pay for want of patronage; the financial condition of the companies therefore is not satisfactory. One company has never paid a dividend on its ordinary shares, and only a very small return upon its preference shares; while the shares of all the other companies are at a discount. Consequently, the companies are unable to carry out improvements and to adopt the modern system of working by electricity, which involves a very considerable capital outlay. Matters were gradually going from bad to worse when the British Electric Traction Company some four years ago first entered into negotiations with the companies and the local authorities.

This company's great aim, wherever it brings its influence to bear, is to ensure that tramways shall be made so frequent, rapid and convenient that the public shall be compelled to make use of them and regard them as an unmistakable boon. Its 33-mile system in the Potteries district of North Staffordshire is known to our readers.

In South Staffordshire the company has been heavily handicapped by local authorities who have hampered and delayed progress by imposing terms too onerous for it to accept, such as the purchase of electrical energy from their power stations at too high a price to admit of the tramways paying at all, and the 1896-97 Bill had to be withdrawn. Having thus found it impossible to proceed with the scheme as a whole, the company was forced to adopt the more lengthy process of developing the enterprise piecemeal, by obtaining the control of the tramway undertakings and by making agreements with the local authorities.

Following out this policy of gradual development, the B.E.T. has made arrangements with all the tramway companies in the district, viz.:—

It owns the Dudley and Wolverhampton line.
It is working the electrical section of the South Staffordshire Company's Tramways, and has obtained an Act of Parliament authorising the South Staffordshire Tramways Company to grant a lease of the rest of its lines.
It holds a controlling interest in the Dudley and Stourbridge Tramways, which it has reconstructed and equipped, and these tramways are now working by electricity to the great satisfaction of the people in that district.
It has arranged with the Wolverhampton Company for the purchase of its lines which are outside the Borough of Wolverhampton, viz., the tramways in Bilston and Willenhall, and Parliamentary powers have been obtained for the adoption of a uniform gauge of 3 feet 6 inches throughout.
It is concluding an agreement with the Birmingham and Midland Tramways Company for the eventual purchase of that undertaking.
Several Light Railway Orders have been promoted for the construction of connecting lines and for the extension of the existing tramways.

The British Electric Traction Company has furthermore already made agreements with many of the local authorities, including the Corporation of Dudley, the Urban District Councils of Amblecote, Bilston, Brierley Hill, Coseley, Sedgley, Stourbridge, Willenhall, and the Rural District Council of Kingswinford. The Corporation of Wolverhampton have inserted a clause in their Bill now before Parliament, by which they agree not to acquire or work any lines in the districts of Bilston, Coseley, Darlaston, Sedgley, or Willenhall, without the consent of the British Electric Traction Company.

The tramways system, however, cannot be perfected and completed without the consent of the other local authorities through whose areas the lines pass, and the refusal of their consent is withholding from the district the full benefit of joint control and of through communication over the whole of the tramways. That such a policy is mistaken is obvious to any impartial student of the question: even a cursory examination of the conditions will show the utter impracticability of the local authorities taking over and working independently the short sections within their areas. Travellers do not want to change cars at the municipal boundaries, but want to move from one centre of population to another. Moreover, if the local authorities of Walsall, West Bromwich, and Wednesbury are determined to work the tramways themselves, they can do so only by breaking up the whole tramways system, because they are only entitled to purchase the various sections of the tramways at certain specified dates, and, as will be seen from the map, they cannot purchase the whole of the tramways until 1905. For the next six years, therefore, the tramways in these districts would be in a state of chaos. In separating themselves from the remainder of the system these local authorities will isolate themselves completely; the tramways under their control will be too small to be worked at a profit, and the service and management will necessarily be far less efficient than those of the big system outside.

In the further development of its scheme the British Electric Traction Company will meet with fresh opposition, and new problems will be cropping up at every stage. Further extensions and connecting lines may be made later, but the various existing companies must first be brought into a thorough state of efficiency by the adoption of electric traction under uniform management.

If the company is allowed to complete the work, a passenger will be able to enter a car at the Birmingham boundary or at Walsall and travel to almost any other part of South Staffordshire, and even run out as far as Kinver, a favourite holiday resort.

It goes without saying that so great an undertaking as this is only possible by private enterprise, and we cannot help adding that a great deal of credit is due to the B.E.T. Co. for the untiring way in which its officials proceed with the very difficult negotiations with opposing local authorities.

Electric Railway: Offers Wanted.—The electric railway at the Alexandra Palace, Wood Green, has been acquired by Messrs. Saunders, Todd & Co., of Newcastle-on-Tyne, who are inviting offers for it, and from whom full particulars may be obtained.

SOME FEATURES OF THE ELECTRIC INDUCTION MOTOR.*

By Prof. C. A. CARUS-WILSON, M.A., M.Inst.E.E.

The action of a magnetic field upon a conductor carrying an alternating current might be illustrated in a simple manner by placing an incandescent lamp in the neighbourhood of an electro-magnet and connecting the lamp to an alternating supply circuit. If the magnetic field were uniform, the filament would vibrate in front of the magnet, and if the vibrations could be minutely studied they would be found to increase first of all to a maximum in one direction, then fall to nothing, and then reach a maximum in the other direction, following a harmonic law. The variations of the force on the filament were similar to those which took place in a steam engine, where the turning moment on the crank went through a complete cycle from a positive to a negative maximum, the law of variation being harmonic if the steam pressure were constant and the connecting rod of infinite length.

The conditions under which the conductor vibrated could be shown more perfectly if it were possible to attach a mirror to the conductor and reflect a beam of light therefrom. But in order that the motion of the conductor should give a true indication of the force acting upon it, the moving part must have a very small periodic time and be perfectly dead-beat. These conditions were fulfilled in a remarkable way in the oscillograph recently designed by Mr. W. Duddell, who had kindly lent one of his instruments for the purpose of illustration. In this instrument the conductors were metal strips stretched in a magnetic field; a minute mirror fixed to the strips reflecting a spot of light on to the screen. The delicacy of the arrangement was such that the period of vibration of the mirror was only the two-thousandth part of a second.

When an alternating current was passed through the strip, the magnetic field being constant, the spot of light on the screen assumed an up and down motion in a straight line. It was possible, however, to indicate the true nature of the law of motion by making the beam of light on its way to the screen strike on a mirror which moved to and fro synchronously with the variations of current in the strip. The spot then followed a wave-like course, tracing out an S-shaped figure. If the spot moved quickly enough, the successive impressions would remain on the eye for a sufficient length of time to give the effect of a continuous line of light.

When examined in this way, the force due to a constant magnetic field and a variable current in the strip was seen to vary from nothing to a certain maximum, then to nothing again, then to change sign and increase to an equal negative maximum, and finally to fall to nothing. The strip was thus subjected to a series of equal impulses varying in sign, so that the resultant impulse was zero.

To prevent the impulses from changing sign, it was necessary to make the magnetism change sign at the same time as the current. This could be done by exciting the magnet by an alternating current in step with that in the strip. When this change was made, the spot of light was seen to fluctuate up and down from a fixed line, instead of alternating as before, showing that the strip was now subject to a series of fluctuating impulses. There were, however, dead points at which the strip was not subject to any force. It appeared then possible to combine an alternating field with a conductor or conductors carrying an alternating current in such a way as to obtain a series of unidirectional impulses, and motors had been constructed on this principle. Such motors had the disadvantge of dead points, and uniform motion could be obtained only by making the moving parts of considerable weight, so that part of each impulse was stored up as kinetic energy, and the dead points thus successfully passed over.

The dead points could be avoided in a manner often used in steam engines, where two separate cylinders were set so that when the action of one on the crankshaft was a minimum, the action of the other was a maximum. This principle could be carried out far more completely in an electric motor than in any other form of motor, for the reason that in a steam engine, for instance, the force of each one of the two cylinders varied according to a harmonic law, with uniform steam pressure, and two series of harmonic impulses at right angles did not give a uniform turning moment, with the electric motor, on the other hand, the law of force variation with synchronously varying field and current was not a harmonic law—as might be seen by the shape of the curves on the screen—but a law having the remarkable peculiarity that two such series of impulses at right angles gave a uniform impulse when acting together. It was thus possible to construct an alternating electric motor in which the sum of the turning moments on the shaft was a constant quantity. The induction motor was such a motor.

Taking the fixed coil, A, shown in plan in the figure, to represent the magnetising coil used in former experiments, and the moving coil, B, to represent the conductor or strip, the condition of a unidirectional fluctuating impulse from A to B was, that the magnetism of A should be in step with the current in B. To produce the latter, recourse might be had to the principle of induction, by which currents could be induced in coils through which an alternating magnetic field was allowed to pass.

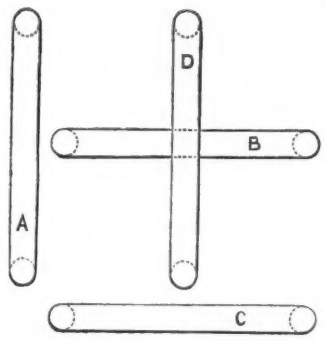
By way of illustration, coils A and B were placed opposite and parallel to one another, each being connected to a separate strip on the oscillograph, in which the magnetic field was kept constant. When an alternating current was passed through A, a current was induced in B, and the two currents were shown on the screen in the

* Abstract of a lecture before the Royal Institution of Great Britain, Friday, April 28th, 1899.

form of two curves overlapping each other. The explanation of the overlapping was that the induced current in B was not in step with the magnetism produced by A, but lagged behind it by an amount of time equal to a quarter of a period.

This lagging of the induced current behind the inducing magnetism had an important bearing on the motor problem, because it showed that it was not possible to make the magnetising coil, A, induce in coil B a current suitable for producing a unidirectional series of fluctuating impulses, since the necessary condition was that the current in B should be in step with the magnetism produced by A.

If a second magnetising coil, C, could be used, in which the current differed from that in A by a quarter of a period, it could be made to induce currents in B which were in step with the magnetism produced by A. The intermediate coil, B, would then be subject to the



influence of two coils, A and C, of which the former produced an alternating magnetic field, and the latter an induced alternating current in step with that field, the two together giving a series of unidirectional fluctuating impulses.

The magnetising coil A exerted the greatest force on the coil B when the planes of the two coils were at right angles to each other, and the coil, C, induced the greatest current in B when their planes were parallel. Hence it followed that the best effect was obtained by placing the planes of the coils A and C at right angles to one another, and B at right angles to A, as in the figure.

If a second intermediate coil, D, were placed across coil B, there would be currents induced in it by A, and a force exerted on it by the field due to C, resulting in a series of impulses similar to those acting on B, but differing from them by a quarter of a period. The sum of the two sets of impulses on the intermediate conducting system was a uniform twisting moment.

If the two coils, B and D, were replaced by a continuous conductor—such, for instance, as a copper drum—this action could go on while the conducting system rotated. In the experiment shown, a copper drum was suspended in front of two coils placed at right angles and excited by currents differing by one quarter of a period. When both coils were excited the drum rotated at a uniform speed.

A striking feature in the induction motor was the rotating magnetic field caused by the variations of magnetism in the different coils. This was illustrated by an experiment in which a small permanent magnet carrying a mirror was centred upon a vibrating rod placed between two pairs of electro-magnets. When two opposite magnets were excited the mirror vibrated between them, and reflected a spot of light on to the screen, tracing out a vertical line. When the second pair of opposite magnets was excited the spot traced out a horizontal line of equal amplitude. Both sets were then excited together by currents in step with each other, with the result that the spot vibrated in a line making an angle 45° with the former lines of vibration. When the exciting currents were made to differ by one quarter of a period, the spot of light reflected from the mirror described a circle, showing that the magnetic field produced by two magnets set at right angles and excited by two currents differing by a quarter of a period is of uniform intensity and rotates at a uniform rate.

The action of the induction motor was based on principles which governed the action of the better known transformer, and for purposes of calculation it was convenient to regard the induction motor as a transformer. One form only of the induction motor had been alluded to; of other possible forms, that in which three magnetising coils were used, with currents differing from one another by one-third of a period was the one most commonly employed in practice.

THE PENALTY CLAUSE.

The non-fulfilment of a contract within a specified time frequently involves the payment of a penalty by the party at fault. While the clause which imposes this liability remains in obscurity when orders are few and far between, it forces itself into a position of unpleasant prominence when orders are many and trade is brisk. Although sometimes inserted in order to act as a deterrent against unreasonable delay in the performance of his contract by the undertaker, it sometimes operates to materially reduce the profits of an adventure. This being so it may be useful to draw attention to some of the legal questions which arise in relation to the penalty clause.

The word "penalty" in this connection indicates that breach of contract may involve a liability altogether out of proportion to the actual damage sustained. The parties, instead of relying upon the remedies provided by law, themselves agree to ensure the fulfilment of contractual obligation by fixing the damages beforehand. But where damages are capable of easy estimation, and where it can be proved to the satisfaction of a court of law that the actual damage sustained is far short of the penalty inflicted, the judges have ever since a famous case in the Chancery Court known as Sloman *v.* Walter been ready to grant relief. Thus at the present day, where the extent of the injury sustained can be clearly estimated in pounds, shillings, and pence, the Court will declare the penalty clause inoperative and proceed to estimate damages according to the scale whereby they are usually calculated. Thus, in a contract to supply goods of known value by a certain day, let us suppose that each of the parties agrees to pay a sum largely in excess of the market value of the goods. The vendor fails to deliver in time, whereupon the buyer claims the penalty. In such a case the Court says: "Nay, the measure of damage is the difference between the contract price of the goods, and the price at which they could have been obtained in the market on the day when the contract was broken." It follows that if by any chance the market price was lower on that day the Court would only grant nominal damages. The above considerations apply, although the parties expressly agree that the fixed sum shall be regarded as liquidated—*i.e.*, fixed—damages, and not as a penalty.

But where the parties, anticipating the likelihood of a breach of contract on one side or the other, have fixed the sum which is to become payable on such breach, if the damages are such as to be wholly incapable of estimation—especially at the hands of the Court—the law is willing to regard the amount as "liquidated damages," and to order payment accordingly. Thus, suppose there was delay in the completion of an electric lighting station, inconvenience to the public might follow, but according to what scale could the damage be assessed? Clearly upon that, and upon that alone which the parties themselves have invented. The whole question may be summed up in the memorable words of Lord Coleridge: "Where the damage is entirely uncertain and the parties agree upon a definite and not unreasonable sum by way of liquidated damages, then that sum will be regarded and will be recoverable."

The greater number of the contracts with which an electrical engineer is acquainted are of such a nature that the damage caused by their breach is "entirely uncertain." The penalty is indeed a "penalty." What, then, are the circumstances under which contractors are relieved either partially or entirely from the payment of these penalties?

The all too-familiar "strike clause" demands but a passing notice. It serves as an excuse for non-performance within the time, although the strike is brought about by the contractor lowering the wages of his men. (King *v.* Parker, 34 L.T. 887.)

Generally speaking, information as to the interpretation of the penalty clause can best be gleaned from cases founded upon building contracts. While time is frequently "of the essence" of such agreements, the consequences of their breach can only be measured by the parties themselves. We may assume that the following rules which have been laid down in cases upon building contracts will apply with equal force to all contracts where delay in performance involves the payment of a penalty.

In the first place it needs no lawyer to remind us that any undue interference on the part of the employer which causes serious delay or hampers the contractor in carrying out his undertaking will release him from paying penalties. This was decided in the case of Russell *v.* Sa. Da. Banderia (Viscount). (13 C.B.N.S. 149.)

There may be an implied waiver of the right to recover penalties. Suppose, for instance, during the performance of a specific piece of work, to be completed within a certain time, the employer and contractor make terms as to additional works or alterations. This subsidiary agreement vitiates a

claim for penalties, unless it be shown that the time spent upon the whole job was unreasonable (Thornhill *v.* Keats, 8 C.B. N.S. 831), or unless the contractor definitely renews his undertaking to complete the entire work within the limited time.

Where an agreement to complete the work by a certain date contains a clause providing for the execution of any additional works which may from time to time be demanded by the engineer, there is no implied term that the additions shall be such as can be reasonably performed within the time. (Jones *v.* St. John's College, Oxford, L.R. 6 Q.B. 115.)

In addition to other powers which are usually vested in him, an engineer is sometimes permitted to order additional works, and to grant to the contractor a proportionate extension of time within which to perform his contract. In a curious case decided some years ago, it was held that under such circumstances, if the engineer omits to grant an extension, the unfortunate contractor becomes liable to penalties in accordance with the original contract. (Tew *v.* Newbold on Avon District School Board, 1 C. and E. 260.)

The above rules may be summarised thus:—

1. The total destruction of the work in hand, *e.g.*, by fire, releases both parties.

2. Interference by the employer (or contractee) which causes delay, negatives his right to penalties.

3. Additional works or alterations need not be executed within the time limited by the penalty clause, unless there is an express agreement to that effect.

Penalties are easily collected, inasmuch as they can be deducted from the contract price. Acceptance of the completed work after the specified time sometimes operates as a waiver of penalties. (Lucas *v.* Goodwin, 3 Bing. N.C. 737.) Moreover, if it can be shown that the delay was caused by additional works, it is clear that there can be no set off of the amount claimed for penalties against the contract price.

FOG SIGNALLING ON RAILWAYS.

"The season when fogs and snowstorms may be expected is approaching, and the attention . . . ."

Many of us are familiar with circulars addressed to the staffs of our railways, at this season of the year, of which the opening terms are, more or less, as the above quotation; and, already, the daily papers are recording accidents to trains, with consequent loss of life and damage to property, owing to the prevalence of fog.

During the last week or two exemption from fog for the whole of the 24 hours has, in the provinces, been the exception rather than the rule; and the old question, of the sufficiency of the existing means of signalling under such circumstances, comes to the front again with all the force due to the occurrence of accidents of a more or less serious nature.

Without in any way attempting to apportion blame for accidents which will no doubt be the subject of inquiry, it may be said that the subject has sufficient importance of its own to justify reference at this time. The public are quite as much concerned as the railway companies, which, indeed, exist for their convenience.

It may, therefore, be fairly asked whether the time has not now arrived when railway companies should discard so antiquated a system as hand fog signalling; or at least give full and fair trials to other systems, with a view to their early adoption if found satisfactory.

There are, no doubt, some to whom the existing system is all that can be desired, but, in the majority of such instances, their opinions are due to arm-chair consideration, and they lack that intimacy with the conditions obtaining which can only be got at first hand.

The old wheeze which depicted the engine driver ascending a signal ladder with his hand lamp, in order to ascertain whether the signal was "off" or at "danger," is not only an exaggeration, but absolutely misleading. On the contrary, the driver has to run to a schedule which makes no allowance for exceptional circumstances such as are under consideration; the all-right signalling is of a negative character, and he continues to run until stopped by the regular intimation—or otherwise. Under such circumstances the driver must possess at least a portion of the indifference to consequences which dictated the alternative, "Westminster Abbey or a peerage." He, of course, does not anticipate so much honour, whatever the event. One has, however, heard him give expression to the same sentiment as "H-ll or ———," and doubtless he knew best what to anticipate in the event of the worst.

Putting aside such grim pleasantry it is to be hoped that the question of better methods of signalling, under abnormal conditions such as are due to fogs or snowstorms, will not be allowed to drag on in the way that the provision of an efficient means of communication with passengers in trains has done.

A few months ago some remarks on the latter form of signalling appeared in these columns, and very shortly afterwards a meeting, such as had been suggested, was arranged, and a decision come to. It is sincerely to be hoped that similar concerted action will soon be taken to deal with the question of signalling "during fogs or falling snow."

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1899.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

20,180. "Improvements in the means of connecting electric tramcars with overhead wires." G. Pinnington. Dated October 9th.

20,189. "Improvements connected with indicating or recording and controlling the speed of electric railway cars or vehicles and other machinery." G. H. Nisbett. Dated October 9th.

20,207. "Improvements in electric telegraphs." C. Adams-Randall. Dated October 9th.

20,214. "Improvements in or connected with electrolytic bleaching of baled yarns." A. A. Vogelsand. Dated October 9th.

20,216. "Receiving apparatus for high speed telegraphy." Siemens Bros. and Co., Limited. (Siemens & Halske Aktien Gesellschaft, Germany.) Dated October 9th.

20,227. "Improvements in electric tramways and in motor cars therefor." A. M. Taylor. Dated October 9th.

20,237. "Improved manufacture of articles plated with platinum, gold, and silver by electrolysis, and apparatus therefor." L. Bourdillon. Dated October 9th. (Complete.)

20,249. "Improvements in apparatus for detecting and measuring or comparing the strength of electrically produced etheric waves, impulses, or vibrations commonly known as Hertzian waves." A. B. MacGregor. Dated October 9th.

20,261. "The improved electric incandescent lamp." E. S. Ellis. Dated October 9th.

20,277. "An improved electrical selector switch." A. Eckstein and H. J. Coates. Dated October 10th.

20,290. "Appliance for imparting electricity and heat to the body." I. Timar. Dated October 10th. (Complete.)

20,298. "Improvements in and connected with electrical indicating, measuring, and recording instruments." M. Waddell. Dated October 10th. (Complete.)

20,307. "Improvements in guides for trolley or collector pulleys on the overhead system of electrical tramways." F. L. F. Boudry. Dated October 10th.

20,313. "An improved attachment to be applied to the new Scandinavian table telephones." S. Percy. Dated October 10th.

20,316. "Troughs for electric cables." W. Sykes. Dated October 10th.

20,321. "Improvements in the construction and arrangement of electrical resistance coils." W. G. Pye. Dated October 10th.

20,328. "Improvements in or relating to dynamo-electric generators or transformers." J. K. Robison. Dated October 10th. (Complete.)

20,346. "Improvements in the manufacture of incandescing electric lamps." W. L. Voelker. Dated October 10th.

20,360. "Improvements in chimneys for incandescent or other gas, oils, electric, or other lights." J. Marshall. Dated October 11th.

20,383. "An improvement in incandescent electric lamps socket junction bodies." C. A. Swan. Dated October 11th.

20,389. "Improvements in transmitters for Morse alphabet and printing telegraphy." L. Cerebotani and C. Moradelli. Dated October 11th. (Complete.)

20,390. "Improvements in apparatus for automatically connecting any two of a number of electric circuits branching from a central station." L. Cerebotani. Dated October 11th.

20,403. "An improved electric lamp." L. Coen and C. Cohen. Dated October 11th.

20,412. "Improvements in electric railways working on the surface contact system." R. Lundell. Dated October 11th. (Complete.)

20,438. "Improvements in means for holding shades or globes for electric and other lights." J. Barker. Dated October 12th.

20,480. "Improvements in electric arc lamps." C. Curwen. Dated October 12th.

20,486. "Improvements in electrical distribution switch and fuse boards." A. Jaray. Dated October 12th. (Complete.)

20,493. "Improved electrical signalling system for railroads." G. Berry. Dated October 12th.

20,504. "Improvements in batteries or apparatus for producing ozone." C. A. Sahlstrom. Dated October 12th.

20,507. "Electric igniter for gas." H. von Arnswaldt. Dated October 12th (Complete.)

20,534. "High voltage electric lighting ceiling rose." T. S. McLaren. Dated October 13th.

20,544. "A waterproof compound action electric bell." R. Bowman. Dated October 13th.

20,549. "A portable electric incandescent coloured lamp or dark lantern for photographic purposes." A. L. Adams. Dated October 13th.

20,605. "An apparatus for preventing sparking and making better contact with the conducting cable and trolley arm in electrically propelled vehicles." J. K. Stanley. Dated October 14th.

20,607. "A system for translating and relaying telegraph cable signals." J. P. Gorton. Dated October 14th.

20,615. "An improved electric safety apparatus for lifts and elevators." J. Bush. Dated October 14th.

20,655. "Apparatus for use in forming joint ends on electrical conduits, drain pipes, and the like." The Albion Clay Co., Ltd., and R. A. Lawton. Dated October 14th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

1,803. "Improvements in and relating to electric arc lamps." L. B. Codd and J. A. Codd. Dated January 22nd, 1898. Relates to arc lamps.—Brake regulating mechanism is constructed as shown. The carbon-holders are hung in guides by pairs of cords which pass over guide-wheels to opposite sides of a double pulley attached to a brake pulley. A chain or cord makes a complete turn round the brake pulley, and is attached at its ends to unequal arms of a lever. This carries cores below series and shunt solenoids, and is weighted so that the longer end, below the series solenoid, descends and slackens the cord when the lamp is not in operation, allowing the carbons to move together. When current is supplied, the series core rises, tightening the cord on the brake pulley, and turning this so as to strike an arc. 2 claims.

1,912. "Improvements in telephones." J. D. F. Andrews. Dated January 24th, 1898. Microphones are formed of carbon or other granules, dust, &c., enclosed in a space or spaces in a flexible or elastic washer placed between two membranes, a membrane and a block, or two discs separated by a membrane and having blocks on their outer surfaces. The elastic material may be formed of carbon dust or granules and a binding substance. Receivers are formed of various patterns in which the magnet may have a diaphragm at either end supported by their edges, or two diaphragms at each end centrally supported. The two diaphragms may also be separated by a coil without a magnet. The magnet may also have a tubular casing acting as an outer pole on a single diaphragm. The microphone and receiver may be combined as one instrument, a double coil being wound on the magnet. This form of apparatus may be employed as a relay. 5 claims.

2,021. "Electrical log recording instrument for the cabin." P. Jensen. Dated January 25th, 1898. The hand is driven over the dial by electric means, that is, by a ratchet wheel advanced by a pawl arm on a bell-crank lever. At certain fractions of a mile the log completes circuit for a magnet and when contact is again broken a spring returns the pawl arm and rotates the wheel. A contact s attached to an annular dial graduated reversely to the dial, and a knob is provided for adjusting this annular dial so that the hand touches it after a given distance has been run and completes circuit for one or more alarm bells in various places on the ship. All these bells, except one, may be cut out when desired. Circuit is completed by the log, say at the completion of every mile, for an electro-magnet which, attracting its armature, pricks a hole in a paper band drawn forward by rollers actuated by the clock. A procker on one of these rollers punctures the strip every hour by the side of the distance record. 4 claims.

2,040. "An electrical fire call." W. Bienheim. Dated January 26th, 1898. Relates to a fire call system in which the firemen are rung up at their houses at the same time that an indicator is dropped at the fire station. A magneto generator sends alternating currents through the line wire to actuate the indicator at the central station. The bells in the firemen's houses are made with high self-induction, so that the alternating currents do not ring them, though they are connected to the single line wire. The alternating current from the magneto generator throws a battery into circuit with the bells, which are then rung by this continuous battery. This arrangement prevents the firemen from being rung up by leakage currents. 1 claim.

2,389. "Improvements in secondary batteries." J. V. Sherrin. Dated January 29th, 1898. Relates to electrodes of the kind described in Specification No. 16,516, A.D. 1896. One form consists of a central, solid, or hollow core, and conducting wires wound helically around it, and around the wires is helically wound a strip of springy conducting material. The active material is packed in until it is flush with the helix, and outer rings of non-conducting material are placed on the ends of the electrode, or the electrode is enclosed in a wrapper of non-conducting material formed by winding a perforated strip of celluloid around it. Another form of electrode consists of a ribbed conducting piece, the ribs being preferably helical covered with a conducting strip, and provided with non-conducting material as described above. Another form consists of a central conducting cord, rings of ebonite, another ring or cushion at each end, but instead of the said cushion the electrode may have a strip of ebonite wound helically around it. Another form consists of a lead conductor arranged as a zig-zag bar with two side pieces and provided with slits. Around this is wound a helix of conducting or non-conducting material, and ebonite rings or their equivalent are fitted on the ends of the electrode. 6 claims.

2,417. "Electric circuit breakers." M. Bouchet. Dated January 29th, 1898. (Date claimed under Section 103 of Act, 1883, July 2nd, 1897, being date of application in France.) A vessel is divided into two compartments and filled with mercury to a certain level. Each compartment is connected to one of the terminals. On lowering a plunger the mercury level is raised and the circuit is completed. The plunger may be controlled by hand or by means of an electro-magnet. The electro-magnet may be in the circuit and act only as a cut-out, or it may be in a separate circuit and be controlled from a distance. In one form the plunger is carried by the movable core of an electro-magnet. The iron part of the electro-magnet preferably consists of three pieces, two forming part of the bobbin and the other a sheath. The core is connected by a rod to a lid or cover hinged on the lid by a spring so arranged as to hold up the cover and with it the core and plunger when the core has once been raised. An arrangement for preventing the core from being crossed down by the resetting handle in places where a consumer is exceeding the maximum current allowed, consists of a cam connected to the handle-spindle by a spring and normally held up by a spring. On turning the handle the spring is put in tension until the cam is freed from the spring. It then flies round momentarily depressing the rod and plunger by forcing down the cover. Two or more of these appliances may be connected to form bi-polar, &c., cut-outs, or switches, and the parts may be so connected that the movement of one affects all the others. 9 claims.

2,420. "Improved means for controlling the working of lifts, motors, and other appliances operated by electric energy." W. A. Key. Dated January 29th, 1898. Relates to means for controlling the flow of an electric current, and is especially applicable for use in connection with motors for working lifts or hoists, the object being to avoid shock or jar and sparking upon applying the current. The controlling device consists of a tank containing water, preferably rendered slightly alkaline, in which are fitted two insulated electrodes, which are closed together at their upper part, but diverge, as shown, at their lower part. These electrodes are connected with the circuit, and are separated from each other by a diaphragm, which is attached to one end of a weighted lever pivoted and connected by a link to the starting switch, so that when the switch is moved, the diaphragm is gradually raised, and allows the current to pass through a layer of liquid which, as the diaphragm rises gradually, decreases in width until the diaphragm rises to such a height that the pivoted piece falls and connects the two plates directly together. A dash-pot connected to a lever is provided to retard its movements to a certain extent. 3 claims.

2,423. "Improvements in the manufacture of filaments for incandescent electric lamps." R. Mullard. Dated January 29th, 1898. Relates to incandescent lamps. Filaments of high resistance are made from carbides of calcium, barium, strontium, iron, zinc, copper, aluminium, magnesium, manganese, boron, or silicon, which may be mixed with coke, graphite, or retort carbon. The materials reduced to impalpable powder are mixed with tar, or cellulose, and zinc chloride solution, or other binding material, and squirted, carbonised and mounted as usual. 3 claims.

2,426. "An improved electrical transformer for currents of high potential and variable frequency." A. Wydts and O. M. Rochefort. Dated January 29th, 1898. Relates to induction coils for currents of high potential and variable frequency. The primary coil is wound on a core and enclosed in a glass or like tube. It is supported on washers so that a space is left for insulating material. The secondary winding is composed of a series of coils built up as follows:—A tube of paraffined paper or the like is formed on a mandrel or core, and a coil of wire wound on, each turn being separated by insulating material. A layer of paper is placed on this coil, and then a second coil is wound, and so on. The coils are then immersed in a hot solution of paraffin in petroleum. The coils are then placed in position in the tube and the whole placed in a vessel containing a similar solution which sets to a jelly on cooling. The secondary wires issue through insulating tubes preferably formed of double tubes separated by insulating material. The interrupter consists of a vibrating arm mounted on a spring. It carries a contact dipping in a mercury cup at one end and an armature at the other. The current is supplied through an adjustable contact and spring. The frequency is varied by sliding the contact on the spring. 4 claims.

2,455. "Improvements in electric contacts, suitable for railway signalling and other purposes." R. Burn and A. C. Brown. Dated January 31st, 1898. Relates to a train-operated electric contact, consisting of wire tufts or brushes which are fixed on suitable supports close to one of the rails. When a train passes, the wheels make contact with the brushes and complete the signalling or other controlling circuit from the brushes through the rail to earth. The invention is stated to be applicable for the following and other similar purposes:—For closing a circuit through an audible or other signalling instrument, and through contact mechanism operated by the ordinary signal lever, the circuit being completed through different signalling instruments according to the position of the lever; for putting outdoor signals to "danger" and locking them, and for unlocking them by a second contact when the train has passed out of the section; for locking and unlocking signals and block instruments in cabins; for actuating audible and visible signals in cabins to indicate whether the section is "blocked" or "clear"; for actuating audible line signals during fogs, &c., and for actuating alarm bells to signal the approach of trains at level crossings, &c. The provisional specification also states that the brushes may make contact with an insulated rim or flange on the train wheels, for actuating a signal on the engine, &c., or for the transmission of power for motor or other purposes. 8 claims.

2,479. "Improvements in terminals for electrical connections, especially adapted to incandescence lampholders." G. Byng and H. Bevis. Dated January 31st, 1898. Couplings applicable to the plunger carriers in holders for incandescent lamps. In one form a screw projects from a flat side of the plunger carrier and is perforated transversely to receive the end of the conducting wire, which is clamped by a screw cap. The face of the cap may be recessed to draw the free end of the wire partly around the screw. In another form a transversely perforated screw enters a hole in the plunger carrier; the wire winds on the screw when this is turned. In other forms, the conductor is passed through a hole in the plunger carrier into a hole in the head of a screw inserted in the carrier, or between the eccentric head of a screw and the body of the plunger carrier. 5 claims.

2,485. "An improvement in electric arc lamps." C. Oliver. Dated January 31st, 1898. Relates to arc lamps. A lamp has a tapered rod connected with the carbons and acted on by a clutch connected by a horizontal lever with the cores of shunt and series solenoids, between which the lever is centrally pivoted on a stationary support. In order to render the action of the solenoids on the arc uniform in all positions of the tapered rod and clutch, a weighted cord or chain is attached to one end of the lever and to one carbon carrier, so that its weight is gradually transferred from the lever to the carbon carrier as the carbons are consumed. In modifications, instead of connecting one end of the weighted cord to a carbon carrier, it may be attached to a pulley which is secured to the supporting pulley; the weighted cord may be replaced by a tension spring. 3 claims.

2,584. "Improvements in the manufacture of electric glow lamps." W. L. Wise. (C. Pieper, Germany.) Dated February 1st, 1898. Relates to incandescent lamps. Filaments are made of metallic thorium or alloys of this with metals of the platinum group, and are heated in the residual air in imperfectly exhausted bulbs to oxidise their surfaces. Other metals, the oxides of which have high light emitting power, may be used instead of thorium. 1 claim.

2,723. "Improvements in electric arc lamps." H. Crudgington. Dated February 2nd, 1898. Relates to arc lamps. In a brake lamp the carbons are hung from a pulley on a brake wheel, the upper holder being the heavier. The brake wheel is partly surrounded by a brake band or chain, the ends of which are attached to the short arm of an armature lever and to a drum provided with a weighted arm, the lever and drum being mounted independently on one axle. The armature lever is acted on by a differentially wound magnet. When its longer end is raised, by the action of the series coils, its shorter end pulls the brake band, turning the drum so as to raise the weight and turning the brake wheel so as to strike an arc. During burning, the weight slowly falls, turning the brake wheel and feeding the carbons together, until an arm of the drum engages and raises a screw on the short arm of the lever, slackening the brake band and allowing the brake wheel to rotate. The drum may be acted on by a spring instead of the weighted arm. 3 claims.

1899.

9,566. "Improvements in and connected with electric safety fuses." J. Gray. Dated May 6th, 1899. A hollow screw is inserted from the underside through the insulating base into a terminal block or bus bar or main conductor block. A vertical hole is formed through the terminal block and a pinching screw entered into this hole. 4 claims.

9,632. "An improved high insulation electric lampholder." F. W. Heaton and H. Smith. Dated May 8th, 1899. Relates to a method of fixing terminals in bayonet or other slotted or screwed lampholders. The cords pass together through the collar grip, and then separate to their respective terminals. The pinching screws are recessed, which prevents the terminals from falling through. 4 claims.

10,215. "Improvements in electrolytic apparatus." M. Haas. Dated May 15th, 1899. Relates to improvements in an apparatus for the manufacture of bleaching lye. The liquid is alternately separated into two different streams, and afterwards united again so that whirls are formed and a good mixture of the liquid is attained. 2 claims.

10,815. "Improvements in incandescent electric lamps." C. L. R. E. Menges. Dated May 23rd, 1899. (Date applied for under Section 103, Act 1883, October 27th, 1898, being date of application in France.) Consists of an intimate mixture of metal or other conductor with a non-conductor, such as alkaline earth, for the filament of the lamp. 2 claims.